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THE PSYCHOLOGICAL REVIEW.

UNCONSCIOUS IMITATION IN HANDWRITING

BY DANIEL STARCH, PH.D.

The University of Wisconsin

Imitation is one of the neglected topics in experimental psychology. Several investigations have recently been made on imitation among animals, but there is as yet very little work on imitation among human beings.

The experiment upon which I wish to report is an attempt to make precise measurements of the nature and extent of one type of imitation, namely, unconscious or unintentional imitation. By this I mean the unintentional modification in the performance of a specific act due to the presence of a model of that act at the time when it is being executed. For this purpose it is desirable to use an act which shall involve delicate muscular coördinations, and of which a precise record can be obtained. Fine muscular coördinations are more apt to show slight modifications than movements of the larger muscles.

The act of handwriting was selected for investigation because it fulfills both of these conditions. It is a finely coordinated activity and furnishes an accurate record.

The specific problem in view was this: To what extent, if at all, is a person's normal handwriting modified by a model of script seen during the process of writing? Will a person who habitually writes a slanting script, unconsciously make his letters more vertical when he writes from vertical copy? And will a person who ordinarily writes a vertical hand unconsciously make the letters more slanting when he writes from a slanting copy?

The plan of conducting the experiment was as follows. A set of five leaves was prepared of which the first gave the directions of procedure to the student, the second contained a short paragraph of typewritten material, the third was a page of vertical script, the fourth contained slanting script, and the fifth contained unusually large script. These three samples of writing were taken from the school copy books published by the American Book Co. The leaves were fastened together and placed in an examination blue-book.

The experiment was performed simultaneously on a class of 106 students in psychology at the University of Wisconsin. Each student was provided with a set of sample sheets and a blue-book. Before these were distributed, the class was told that each would receive a blue-book which contained several sheets of paper of which the first would tell them what to do, that they should not examine any of the pages in advance but should use them in the order in which they were put together and that they should immediately proceed to carry out the directions. In order to avoid any suggestion of imitation or even of copying, or of anything in regard to the real purpose of the experiment, the directions were printed and the emphasis was rather put upon the desire to obtain samples of handwriting. The directions were as follows: "We desire records of your handwriting. Will you accordingly write out the words and sentences presented on the pages given you. Kindly do this without further questioning or reflection."

After the writing was finished, which took about twenty-five minutes, the class was asked to state whether they had formed any opinion as to the purpose of the experiment and whether they had intentionally tried to make their handwriting like the copy. Among the 106 persons only two purposely tried to imitate the models, and one intentionally made her handwriting different from the models. Their records were not used in the tabulation of the results. The remaining 103 persons stated that they wrote in their usual manner. The majority had no opinion as to the purpose of the experiment and those who did have an opinion did not form it until toward the end of the experiment.

Results.—Each person tested furnished four samples of writing. The first, being written from typewritten copy, was designed to furnish an illustration of his normal handwriting and would serve as a basis with which to compare the other samples. The second was written from the vertical copy, the third from the slanting copy, and the fourth from the large copy.

In order to determine whether these different copies had any effect, and if so how much, two features of the writing were carefully measured, the inclination and the size of the letters.

1. *Inclination.*—Here it was necesary to measure first the slant of the letters in the normal handwriting, and second the slant of the letters when copying the different kinds of script. Three letters were selected for measurement, *l*, *f* and *p*. The measuring was done by means of a specially prepared scale of lines drawn on transparent paper. This scale consisted of a horizontal base line and a series of cross lines making angles with the base line which differed from each other by five-degree steps (see Fig. 1). In measuring, the scale

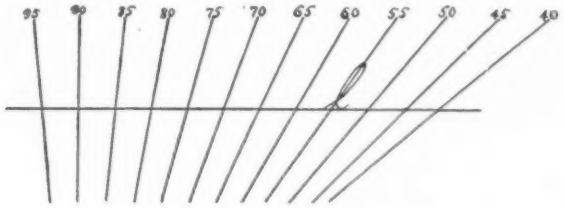


FIG. 1.

was placed over the letter so that the base line coincided with the line upon which the letter was written. That cross line which coincided with the upper and lower points of the letter indicated the angle of inclination. For example, in measuring the letter *l*, the two points which determine the slant are the point where the two lines cross and the extreme tip in the loop.[1]

I will present the measurements of the letter *l* only as the others agree closely with it.

[1] Acknowledgments are due to Mr. A. C. Kroesche for making the measurements.

Average inclination of l in the normal writing ..... 65.1 degrees.
Average inclination of l written from vertical copy..... 68.8 degrees.
Average inclination of l written from slanting copy..... 61.5 degrees.
Change from normal to vertical ..... 3.7 degrees.
Change from normal to slant..... 3.6 degrees.
Total range of change..... 7.3 degrees.

The angle of inclination in the slanting model was 40 degrees and in the vertical model 90 degrees.

In three cases out of 103, there was no change. In thirteen persons the change was slightly negative, amounting on the average to 1.3 degrees. This is probably within the limit of chance variation and does not signify a real negative effect. The maximum positive change was 19 degrees in one individual and 24 degrees in another.

Next, the persons tested were divided into three classes: Those whose normal handwriting was vertical, those whose normal handwriting was extremely slanting, and those whose normal handwriting had an ordinary slant lying between the extremes of the first two. The dividing line between these classes had to be drawn arbitrarily. Among the vertical writers were included all those whose habitual handwriting had an inclination of 75 degrees or above. This included twenty-six persons whose results were as follows:

Average inclination of l in the normal writing ..... 85.2 degrees.
Average inclination of l written from vertical copy..... 87.1 degrees.
Average inclination of l written from slanting copy..... 79.2 degrees.

Hence, the vertical writers, as one would expect, were influenced more by the slant copy than by the vertical copy. In the former case the change was 6.0 degrees, in the latter case 1.9 degrees.

Among the slant writers were included all whose normal writing had an inclination of 55 degrees or less. This included thirty-four persons whose results were as follows:

Average inclination of l in the normal writing ..... 50.4 degrees.
Average inclination of l written from vertical copy..... 53.8 degrees.
Average inclination of l written from slanting copy..... 48.1 degrees.

Hence this class was also influenced most by that model which was most different from their normal writing, namely the vertical. By the vertical copy they were influenced to

the extent of 3.4 degrees and by the slanting model to the extent of 2.3 degrees.

The third class of forty-three persons comprised all whose habitual writing ranged from 55.1 degrees to 74.9 degrees. Their results were:

Average inclination of l in the normal writing ..... 62.6 degrees.
Average inclination of l written from vertical copy ..... 67.4 degrees.
Average inclination of l written from slanting copy ..... 60.0 degrees.

These were influenced more by the vertical than by the slanting model. This is probably due to the fact that the normal inclination of the majority in this class was nearer to the latter model.

The measurements also reveal an interesting difference between the sexes with regard to the force of imitation. The group tested was composed of 28 men and 75 women yielding the following differences:

	Men	Women
Average change from the normal toward the vertical model	4.0°	3.8°
Average change from the normal toward the slanting model	2.0°	3.7°
Entire range of change	6.0°	7.5°

The women therefore showed a change of 1.5 degrees greater than the men. That is, the influence of the two models upon the women was just 25 per cent. greater than upon the men. The men showed a slightly greater change toward the vertical because more of the men were slant writers.

2. *Size.*—The size of the letters was determined by measuring only one dimension, namely their horizontal width. This was done by measuring in millimeters the length of entire words and dividing by the number of letters. Errors of measurement would thus be smaller than in measuring separate letters. The following results were obtained:

Average width of letters in normal writing ..... 4.33 mm.
Average width of letters written from large model ..... 4.85 mm.

The width of the letters in the model was six mm. Hence the large model had the effect of increasing the normal width of the letters by .52 mm., or 12 per cent. While this seems a rather small quantity, it would nevertheless amount to half a centimeter in a word composed of ten letters.

One person's writing showed no change in size and four-

teen showed a slight negative change amounting on the average to 0.26 mm. This no doubt also comes within the range of chance variation. Sixty-four persons showed a change in size of from 0 to 1 mm., twenty-two persons from 1 to 2 mm., and four persons from 2 to 2.8 mm.

Summary.—A quantitative method of measuring unconscious imitation has been demonstrated. This method might well be used to study the genetic development of imitation by making the experiment with pupils of different ages.

All persons seem to manifest this type of imitation. Those whose writing showed no change in the inclination did show a change in the size of the letters. The experiment thus emphasizes the subtle way of learning through unconscious imitation.

The measurements show a greater tendency toward imitation among the women than among the men.

There is a positive correlation between change in slant and change in size. That is, those persons who showed a large amount of change in slant also showed a large increase in the size of the letters.

A PRELIMINARY NOTE ON THE CATEGORIES OF ASSOCIATION REACTIONS[1]

BY FREDERIC LYMAN WELLS

Psychiatric Institute, Ward's Island, N. Y.

With the rapid growth of the material centering about the discrete free association test, its interpretations are becoming more definite, and its significant features more clearly understood. Methods of treating the data that shall most clearly and reliably measure these features are the most to be desired.

In the valuable study of Kent and Rosanoff, considerable distrust is expressed of dealing with the responses on the basis of the quasi-logical categories, because of their vagueness and subjectivity. A somewhat similar opinion has been expressed by the present writer. At the same time, it could obviously not be supposed that the further development of the association test would render it possible to dispense altogether with this principle of classification. It is as impracticable to make frequency tables for all association words as it is desirable to state their results in a more significantly descriptive form than they permit.

As the end result of the experience with material dealt with in two recent papers, it seemed that the categories that showed sufficient definiteness to make it possible to preserve them, and sufficient significance to make it worth while to do so, were five in number: (1) the predicates, (2) the supraordinates, (3) the contrasts, (4) a miscellaneous group, roughly one half the total, and (5) the reactions directly dependent upon speech-habits. Compared with the classification previously used, the categories corresponded as shown on the following page.

Any results by the two methods could thus be compared by simply 'telescoping' the former to fit the latter classification. But the analysis of 1,400 further reactions of the Kent-Rosanoff series in company with their frequency co-

[1] The experimental material is from the psychological laboratory of the McLean Hospital.

1. Failure of Response	Non-existent in the material thus analyzed.	
2. Direct Egocentric		
3. Egocentric Predicate		1. Predicate.
4. Judgment of Quality		
5. Simple Predicate		
6. Subject Relation		
7. Object Relation		
11. Supraordinate		2. Supraordinate.
12. Contrast		3. Contrast.
8. Causality		
9. Coördination		
10. Subordination		4. Miscellaneous, or, essentially, 'Internal-objective.'
13. Coexistence		
14. Identity		
also, Doubtful		
15. Language-motor		
16. Word compounding and completing		5. Speech-Habit.
17. Pure sound associations		
18. Syntactic change		

efficients disclosed remediable defects in this system, which were now not so much in the nature of a lack of objectivity as in a tendency to obscure what were otherwise indicated to be significant characteristics. In accordance with these, a further modification of the system was indicated, which affected essentially the category above termed the predicates. This subsequent modification has since been tested, in substance, in the original classification of some 6,000 associative responses without suggesting any modifications of importance beyond those mentioned. In view of subsequent contributions based upon them, it may be permissible to print a brief account of the categories as they at present stand.

The categories continue five in number, being now termed the *egocentric*, the supraordinate, the contrast, the miscellaneous, and the speech-habit. The task of defining them may be attempted as follows:

1. The egocentric category ranges in numbers from the largest to the smallest and has included from 2 to 60 per cent. of the responses in single records. In long series of experiments its averages range from 16 to 44 per cent. Upon the definition of this category from the others, hinges the real import of the entire system. It is pretty generally recognized that the essential value of the association test lies in the

indication not of the subject's intellect, but of a perhaps even more important factor of conduct, the extent to which situations are referred to, and interpreted in terms of, special personal experience. In the egocentric category is attempted the separation of these stimulus words so interpreted in terms of personal experience, from those in which the relation is predominantly objective. It has seemed desirable to include:

a. Reactions of modification. These constitute the bulk of the egocentric category. Most of them, further, would be included in the predicate category of Jung and Riklin, and their character may be illustrated in such examples as *cloud-ominous*, *flower-pretty*, *crooked-line*, *red-rose*, *scratch-cat*, *lion-roar*, *money-wish*, *invent-machine*, *weasel-stealth*, *beauty-rose*, *safe-quite*, *almost-grown*, *sing-well*, *never-decide*, *nicely-very* (including the responses *yes* and *no*).

b. Reactions in which the response is a proper name; *e. g.*, *citizen-New York*, *boy-Johnny*, *mountain-Kearsarge*.

c. Reactions in which the stimulus word is interpreted as a proper name; *e. g.*, *eagle-newspaper*, *park-street*.

d. Reactions in which the response involves a pronoun; *e. g.*, *hand-you*, *health-me*.

e. Failures of response or repetitions of the stimulus word.

It is probable that this category should also contain associations where coherence is exceptionally vague, as *whistle-nature*, *dream-behave*, *stem-fishes*, *hammer-court* (Kent and Rosanoff), though they have not been placed here in the present analyses. Their number is insignificant in normal subjects, but the question would be important in dealing with pathological cases, and should be decided in this way.

2. Contrary to usual practice, the supraordinate category is now confined strictly to the individual-genus order. The conception may be defined in such examples as, *priest-man*, *potato-vegetable*, *lily-flower*, *cow-animal*. The category does *not* include part-whole reactions; *arm-limb*, or *arm-member*, are supraordinate reactions within the present conception; *arm-body* is not. This is done to bring it in closer relation to the 'non-specific' category of Kent and Rosanoff with the interpretations thus gained for it. A large number of such reactions seem to indicate an inferior adaptation to the experi-

ment; they tend to disappear with practice. In single records the category may range from 1 to as high as 35 per cent. of all reactions *during initial experiments*.

3. The contrast group in a random series of stimulus words ranges from 1 to 30 per cent. of all reactions. It is composed, of course, of reactions in which the response means the opposite of the stimulus; and is made up of such associations as, *good-bad*, *trouble-pleasure*, *scatter-gather*, *fertile-sterile*, and the like. Its significance is mainly a negative one, in that a markedly egocentric reaction tendency appears to go hand in hand with a prejudice against the contrast reactions.

4. The miscellaneous category (averaging about 45 per cent.) is much the largest of all, save in subjects of markedly egocentric tendencies, in whom this category may exceed its numbers. It is composed essentially of the remaining reactions of the 'inner' type, as Jung, following Aschaffenburg, uses the term. These include, by name, causalities, coördinates, subordinates, coexistences, and identities (synonyms). Reactions of doubtful assignment may also be placed here without essentially affecting results. The predominance of this heterogeneous group indicates a 'concrete' reaction tendency as distinguished from an egocentric one; it has not seemed that anything was gained by separating even its more obvious components.

5. The speech-habits group tends to range up to 15 per cent. of all reactions in different subjects. It is composed essentially of the four sub-classes previously indicated, and is exemplified in such reactions as, *stand-pat*, *play-ground*, *tease-sneeze*, *high-height*. It is the most superficial of all the groups. Doubtless many are suppressed owing to this very superficiality and apparent lack of intellectual dignity. Now and then, of course, such a reaction may occur as a means of escape from emotional suppressions, but this does not seem to be a significantly frequent process.

To sum up, the examination of some 5,000 association reactions has indicated a system of classification preserving itself without suggesting other than trifling modifications, through a material of some 6,000 more. The categories are five in number, consisting of (1) the *egocentric*, including such

reactions as appear to be conditioned by a special subjectivity of attitude, *eine besonders persönliche Stellungsnahme* with reference to the stimulus word; (2) the *supraordinates*, or individual-genus reactions, which possess a certain psychological relation to the egocentric that is, however, too involved to discuss here; (3) the *contrasts*, or associations by opposites, which represent a tendency related rather to the concrete type; (4) a *miscellaneous* group, including the remainder of the 'inner' associations, whose predominance essentially determines the 'concrete' association type; (5) the *speech-habits* category which results, psychologically, from a greater degree of the same 'objective' associational tendencies that determine the reactions of the miscellaneous group.

It is believed that this system of treating the data will, in the simplest way, show the important things about an associational tendency that the quasi-logical method is capable of showing. Its main weakness lies in the insufficient definition of the more highly egocentric responses. As determiners of egocentric reaction type, a few associations such as *working-comfort*, *lamp-smoky*, *woman-Bible*, *health-golf*, *window-joyful*, *memory-painful*, *dream-anger*, *swift-motoring*, *sleep-poorly*, *boy-funny*, *cabbage-stinking*, *wish-disappoint*, *yellow-nice*, *stomach-distress*, may well be worth a copious number of superficial predicates like *sweet-candy*, *baby-small*, *dark-night*, *whistle-blow*, *thief-steal*, *cold-ice*, *sour-lemon*, *smooth-glass*,[1] but there is no way of objectively distinguishing them save on the basis of statistical frequency. The associations of the 'familiar phrase' order must always depend upon the experimenter's estimate of what shall constitute 'familiarity' before the association shall be put in the speech-habits category rather than in a higher one whose conditions it logically satisfies, as the egocentric, *e. g.*, *sour-grapes*. Statistical analysis, where possible, is the only method of dealing with such cases as individual observations; but they do not appear sufficiently important to distort or even obscure the basal trends of association-reaction through fairly extensive series of observations.

[1] From the Kent-Rosanoff material. The first group are all 'individual reactions'; the average frequency of the second is 11.2 per cent.

JUDGMENTS OF PERSUASIVENESS

BY H. L. HOLLINGWORTH
Barnard College, Columbia University

INTRODUCTORY

The present study represents a two-fold endeavor. In the first place it is an attempt to learn something concerning the variability and consistency of the judgment of interest among different individuals and with the same individual under changed conditions. In the second place it is a preliminary attempt to learn something of practical value concerning the relative strength, permanence and universality of various interests, instincts, and conceptions as a basis of appeal in such practical operations as advertising, salesmanship, etc.

The first problem is of considerable interest for pure psychology. The statistical study of judgments has too long been confined to the comparison of simple sensory stimuli. A psychology which aims to be an account of behavior cannot go far without making a careful study of more complex judgments such as those of appeal and interest. Such a psychology is more interested in performance than in capacity. Psycho-physical measurements have failed to throw much light on the individual's actual performance in competitive life, and this must always be the result of capacity measurements under laboratory conditions. The concrete psychological life depends not on capacity alone, but largely on motive; and a psychology of behavior, as distinguished from a psychology of content (element and attribute), will be interested in performance, in the degree to which motive and capacity sustain each other. Especially will this be true of a psychology which aspires to be concretely serviceable. Such a psychology will find but little use for the introspective method. It will be interested, not in the momentary content of a conscious moment; nor in the descriptive character of

the sensory fragment which may at the moment be the bearer of meaning; nor in the instrument, criterion or vehicle of an act of apprehension, a comparison, a feeling or a choice. It will be most of all interested in the outcome of this moment in the form of behavior, an act, a choice, a judgment, and in the character, reliability, constancy and significance which the outcome of a mental operation bears. Such a psychology must undertake a study of the range, the distribution, the degree of permanence, and the interconnections of such complex judgments as those of preference, conviction, persuasion, satisfaction, amusement, interest, character, resemblance, etc. A merely analytical and introspective psychology is impotent here. What we want to know is the degree to which the individual performance or interest is typical of the average performance or interest of the group; the amount and rate of fluctuation in the individual from day to day and from epoch to epoch, situation to situation; and, in the group, the dependence of these features on the factor of composition. Such an attempt the writer has already reported in a study of judgments of the comic.[1] The present paper, in its first endeavor, attempts to extend the method there developed to the more complex judgments of interest and persuasiveness.

The second purpose of the paper, that of securing information concerning the relative strength of various appeals to interest, attention and response, is justified by purely practical considerations. The Senate Committee has recently attributed the present high cost of living to advertising. Advertising experts estimate that a billion dollars were spent in their industry last year, and that at least three fourths of this amount was wasted,—that is, that the same results in distribution could have been secured at one fourth the cost, if the methods of announcing and soliciting had been more intelligent. Apparently then it is not advertising, so much as bad advertising, perhaps unpsychological advertising, that is to blame for the committee's report. To men who desire to make their copy effective and at the same time economical, the question of the relative strength of various appeals, in-

[1] PSYCHOL. REVIEW, Vol. XVII., No. 2.

terests, instincts and effective conceptions is a live one. The writer has repeatedly been asked by such men to state the relative strength of various appeals in the case of the ordinary man,—to say in how far certain interests are universal, to what degree certain general types are pronounced, how they are distributed, how such interests are conditioned by age, sex, occupation, locality, race, etc. The practical man expects the expert psychologist to possess such information and he has the right to expect much more than we at present are able to tell him. The writer and his students have for some time been trying to answer such questions by concrete experimental methods. The results of most of these are being presented where the practical man can reach them, but certain more technical interests impel the presentation of some of these results in a psychological journal.

The Present Problem

The problem, then, is the measurement of the validity, variability and consistency of judgments directed toward the relative persuasiveness of a series of appeals. In order to eliminate such widely varying factors as habit, association with particular objects, needs, brands, etc., the aim has been to make the appeal abstract. Fifty abstract appeals, each designed to reach a different interest, instinct or line of argument, were written, corresponding for the most part, to the salient points of various widely differing sorts of advertising copy. This series was given the observer along with the following directions:

DIRECTIONS

(Read these directions two times, carefully, before beginning the experiment.)

This is an experiment in the psychology of advertising. Its purpose will be explained after you have finished the series. Each card contains an advertisement of some fictitious article, indicated by a letter-numeral symbol (thus, 3K7). It need make no difference what the article might really be. It may be well to assume that all the cards advertise different brands or makes of the same article,—some ideal, imaginary article, to which any or all of the advertisements might apply.

I. Read all the advertisements through and arrange them in five consecutive piles, in an order of merit,—according to their *persuasiveness, i. e.*, according to the degree in which they make you *desire* the article or *convince* you of its merit.

There will thus be five degrees of *persuasiveness*, which might be roughly designated:

1. Most persuasive.
2. Very persuasive.
3. Fairly persuasive.
4. Mildly persuasive.
5. Least persuasive.

Arrange the five piles in a row so that Group 1 is at the top, Group 5 at the bottom, and the three other groups in their respective positions between these extremes.

II. Having done this, turn to the top pile (Group 1) and arrange the advertisements in that group in a strict order of merit,—the strongest in the pile thus getting the first position, the next strongest the second position, and so on.

After the top pile is arranged, treat each of the other groups in the same manner. In this way the whole series of advertisements will have been arranged in an order of merit series with respect to their *persuasiveness*,—with the *most persuasive* at the top and the *least persuasive* at the bottom.

III. Without disturbing your arrangement of the Groups, notify the experimenter that you have completed the series.

The fifty appeals are given in the following list. The cards are here arranged in a final order of merit for a group of forty observers, consisting of twenty men and twenty women. The first pair of figures gives the average value and mean variation for the women, the second pair the same for the men.

1. 1K6,—*Scientific.*—Our 1K6 article is manufactured by approved scientific methods and scientifically tested processes, by technically trained men, working under the constant supervision of experts.

2 −*9.1*, 2 −*8.4*.

2. 1W5,—*Durability.*—Combine utility with durability by using 1W5. It lasts one third longer than the ordinary article. Stands the wear and tear of constant use, combining equal quality with greater permanence and longer service.

1 −*8.2*, 6 −*8.0*.

3. 1F3,—*Sanitary.*—This is the only sanitary 1F3 on the market. Put up in germ-proof, dust-proof, hermetically sealed packages, and made of strictly pure and unadulterated ingredients.

5 −*7.7*, 3 −*10.5*.

4. 2D8,—*Efficiency.*—Actual energy, earning power, is what counts in modern business. The day is past when recognition rested on pull and social influence. 2D8 will increase your efficiency 25 per cent. By no other means can you secure such prompt and sure increase of producing capacity.

7 −*12.8*, 8 −*13.7*.

5. 1T8,—*Time.*—Save the minutes and the hours will save themselves. Time is money. Our latest 1T8 is the biggest time saver on the market. Does in twenty minutes what requires, with other brands, a half an hour.

3 −*8.6*, 14 −*12.2*.

6. 1N6,—*Appetizing.*—Try 1N6. It comes fresh from the field and its appetizing flavor is a treat to the palate. It makes a dainty breakfast, a delightful luncheon and a delicious dessert.

13 −*8.9*, 5 −*8.8*.

7. 2B7,—*Family Affection.*—A final day must come to every man, and no one wants to see his children left dependent on mere accident. You owe a duty of provision and foresight to your family. A 2B7 will guarantee their comfort and security when you are gone.

17—*13.5*, 1—*7.7*.

8. 1Z5,—*Value.*—Absolutely superior quality and finer finish. 1Z5 may cost a little more, but it's worth the difference. One trial will convince.

4—*7.3*, 16—*10.1*.

9. 2L7,—*Evolution.*—Our latest 2L7 is the result of generations of experience and experiment. After years of trial 2L7 stands distinctly in a class by itself as the final product of a long evolution,—the climax of mechanical genius.

11—*10.9*, 12—*9.1*.

10. 2C8,—*Ambition.*—There's always room higher up. Capable leaders are always in demand. Why stay among the incompetent when 2C8 will bring you a better position and increase your salary. The man who uses 2C8 is sure of recognition and rapid promotion.

6—*10.9*, 18—*13.5*.

11. 2F6,—*Self Defense.*—Fore-armed is fore-warned. Your life is always threatened by some lurking danger or another. With 2F6 in your home you are always secure and able to protect the rights and person of yourself and of those whose safety is your chief concern.

15—*0.7*, 10—*11.3*.

12. 1R4,—*Reputation.*—Established in 1870, we have been for forty years the leading manufacturers of 1R4 in the country. We have the longest and most enviable record of any house, in our line, on the continent.

9—*12.8*, 21—*12.0*.

13. 2E9,—*Guaranteed.*—Our well-known trade-mark guarantees quality and satisfaction. All our 2E9 is strictly warranted high grade. Your money refunded if 2E9 does not accomplish all we claim for it.

10—*12.7*, 20—*11.4*.

14. 1P5,—*Stimulating.*—1P5 fortifies the body against inroads of toil and disease gives new life and vigor to tired muscles and nerves, and removes unnecessary strain and fatigue.

12—*9.6*, 41—*10.4*.

15. 1V3,—*Safety.*—Avoid danger by using the only absolutely safety-built, and accident-proof 1V3. Do not court danger by taking chances. This is the only 1V3 in which you get all of the protection and none of the risk.

26—*11.5*, 7—*10.2*.

16. 1E5,—*Popular.*—The name is on all tongues. You will find 1E5 in the ladies dressing room, in the scholar's study, in the nursery, in the kitchens of the humble; in crowded eastern cities and on limitless western plains. Used in millions of homes and everywhere it is on top.

29—*13.2*, 4—*9.9*.

17. 2R5,—*Economize.*—A dollar saved is a dollar earned. 2R5 will save you money. Why not cut down expense items and start a bank account. 2R5 will help you do it.

14—*8.0*, 19—*7.3*.

18. 1Q3,—*Maternal Love.*—Nothing is too good for baby. 1Q3 comforts and soothes the little chap and makes of babyhood one happy play time. Assures the children's health and enjoyment.

18—*13.2*, 4—*9.9*.

19. 1J4,—*Modernity.*—Strictly up to date design, with all the latest improvements. 1J4 is equipped with every advantage and ingenious device known to recent invention.

22—*8.8*, 13—*11.6*.

20. 1C3,—*Health.*—As a general tonic 1C3 is unequalled. It nourishes the system, enriches the blood, builds up firm healthy tissue and gives tone and color to the whole body. Prevents grippe and pneumonia.

8—*10.9*, 30—*15.6*.

21. 1X9,—*Quality.*—Why keep on wasting money when for the price of the ordinary article you can get our superior 1X9. Goes farther and does the work better than any other.

16—*12.5*, 22—*9.5*.

22. 1A7,—*Elegance.*—Nothing contributes so strongly to the luxurious comfort of the modern home as 1A7. Its presence gives dignity and elegance to the whole and creates an atmosphere of daintiness and distinction.

30—*10.9*, 11—*10.3*.

23. 1G2,—*Bargain.*—No 1G2 was ever offered before for the money. As good as any others and only two thirds their cost. We are enabled to offer this proposition only by virtue of our mammoth plant and enormous capacity. Why pay more?

28—*11.0*, 17—*12.0*.

24. 2Q7,—*Sympathy.*—Kindness is the first law of humanity. Much of the pain and discomfort inflicted on dumb animals could be relieved by using 2Q7. Be humane to your beast. Use 2Q7.

37—*15.3*, 9—*9.9*.

25. 2O8,—*Necessary.*—You can not afford to do without 2O8. It is indispensable in your home, in your business, in your recreation. Every man, woman and child needs it constantly.

20—*8.2*, 27—*14.0*.

26. 2W8,—*Middlemen.*—Why pay middlemen's profits? Buy direct from the manufacturer and keep the profits yourself. We make 2W8 and ship straight to the consumer.

23—*11.7*, 26—*10.4*.

27. 2Z7,—*Courtesy.*—Nothing is more discourteous than an offensive breath. 2Z7 cleanses the system, purifies the blood and sweetens the breath.

27—*10.1*, 25—*12.0*.

28. 2T9,—*Remarkable Growth.*—The superior quality of 2T9 is demonstrated by the rapid development of our business.

Total Capital,	1890,—	$15,273.00.
" "	1895,—	85,896.00.
" "	1900,—	240,142.00.
" "	1905,—	703,279.00.
" "	1910,—	3,875,639.00.

19—*16.3*, 36—*11.5*.

29. 1S6,—*Amusement.*—Don't look bored! Buy 1S6. The most side-splitting, mirth-provoking novelty ever devised. Amuses old and young. Affords fun and laughter from morning till night.

34—*10.7*, 23—*10.6*.

30. 2X4,—*Hospitality.*—Don't be content with envying the successful hostess when you can secure the same keen pleasure for yourself. The homes equipped with 2X4 are known far and wide for their generous comfort and open hospitality.

24—*8.0*, 34—*11.5*.

31. 2Y9,—*Youth.*—The fountain of eternal youth has never been discovered, but it has been demonstrated beyond a doubt that 2Y9 restores youthful vigor, quickens the step and gives new life to both mind and body.

24—*8.9*, 34—*13.1*.

32. 2V7,—*Hunting.*—Just the thing for the fishing and hunting trip. Ensures a lively spirit in the field and solid comfort in the camp. No vacation outfit is complete without 2V7.

31—*12.1*, 28—*116*.

33. 1O9,—*Social Standing.*—The use of 1O9 is the stamp of the gentleman. It is always found where social standards are high, and is the favorite of men and women of discriminating taste and culture.

38—*9.0*, 24—*12.6*.

34. 2S8,—*Enormous.*—We have the largest establishment engaged in the production of 2S8 in the United States.

Capital, $12,000,000,000.

Factories or branch establishments in every prominent city in the country.

25—*14.6*, 38—*11.4*.

35. 1Y2,—*Cheap.*—Buy 1Y2. Costs just one half the price of its competitors. Why spend two days' wages when one day's work will bring our high class article to your home?

32—*10.1*, 33—*9.6*.

36. 2J9,—*Get the Genuine.*—Avoid substitutes. Many may pattern after us but none can equal us. As a matter of fact 2J9 has many imitators, but there is only one standard, genuine article. Ask for 2J9.

21—*12.0*, 48—*9.4*.

37. 2P6,—*Progress.*—Don't be a dead one. Use 2P6 and be up to date. It is an essential part of every progressive modern establishment.

40—*11.7*, 29—*12.3*.

38. 2A3,—*Sale.*—We are closing out our large stock of 2A3 at a great sacrifice, to make way for next-year's goods. For the next ten days 2A3 will be sold for less than cost. Come early. Don't miss this rare opportunity.

41—*11.7*, 31—*11.7*.

39. 2M5,—*Excel.*—Don't be a wall flower. Use 2M5 and you will be the envy of all your friends. It gives that look of superiority which every one recognizes and respects but which few possess.

36—*11.7*, 42—*13.0*.

40. 2K4,—*Civic Pride.*—We appeal to your civic pride. 2K4 is made in your own city, by local workmen and backed by strictly home capital. Encourage home industry. Use 2K4.

33—*15.0*, 45—*10.3*.

41. 1H9,—*Patriotism.*—Our 1H9 product is made for American consumers, of strictly American grown materials, by an American firm, employing exclusively American labor and American capital.

35—*15.6*, 43—*10.3*.

42. 2G4,—*Union Made.*—We stand for organized labor. 2G4 is a strictly union-made product, built by union labor, of union raised material, and sold exclusively by all union dealers.

49—*14.6*, 32—*11.6*.

43. 1M8,—*Recommendation.*—Here's what the world famous tenor of the Metropolitan Opera House says of 1M9.

"I have used your product constantly and have continued to derive great benefit from it."—(Signed) Enrico Caruso.

46—*14.0*, 37—*14.5*.

44. 1D8,—*Nobby*.—Our 1D8 products are made by our smartest designers, especially for those who love nobby and dressy styles. Exclusive patterns and dashing cuts, unequalled in snap and color.

48—*7.3*, 35—*10.3*.

45. 1B5,—*Style*.—Our new 1B5, is fresh from the center of fashion, representing the latest creation of accepted artists of style, in exclusive designs and dressy patterns, chic and strictly *a la mode*.

47—*5.8*, 40—*7.5*.

46. 1L7,—*Royalty*.—1L7 will be found in most of the houses of European royalty. We are commissioned by official warrant to supply 1L7 to his Excellency, the Emperor of Germany.

50—*8.5*, 39—*12.1*.

47. 2N7,—*Admiration*.—Do you desire the admiration of those you meet? Use 2N7 and you will be the constant center of attraction to adoring and envious eyes. No jewels or marvels of costuming can add so much to your appearance as 2N7.

43—*9.4*, 47—*11.5*.

48. 2H8,—*Imported*.—All 2H8 products are strictly imported and foreign stamped. 2H8 comes straight from European makers and is superior quality is thereby guaranteed.

45—*10.0*, 46—*9.8*.

49. 1U4,—*Beauty*.—Are you as pretty as you might be? No one wants to be homely. The continued use of 1U4 removes the undesirable blemish, beautifies the complexion, renders the form attractive and gives charm to the figure.

42—*8.9*, 50—*9.9*.

50. 2U3,—*Personality*.—Every one desires to be attractive to the opposite sex. 2U3 will give you distinctive presence and engaging personality which is irresistible in its appeal.

44—*10.9*, 49—*10.2*.

The appeals of the foregoing series were typewritten on separate slips of uniform size. Each card bore a single word or pair of words, designed to emphasize the specific character and direction of the appeal, to reinforce the suggestion or argument offered by the text itself, and insure so far as possible, the same attitude in all the observers in the presence of the respective appeals. By employing such copy the following results are secured:

1. Each appeal tends to be single and uncomplicated by other interests.

2. Each is divorced from reactions to any article or brand as such.

3. The elimination of cuts and the use of the same general style and expression lends homogeneity to the group.

4. A wide range of specialized isolated appeals is secured.

As a result of these conditions, the variations and tendencies disclosed by a study of the judgments may be supposed to depend chiefly on the constancy and universality of the interests themselves and on the characteristics of the judgment of such a subjective thing as *interest* or *persuasiveness*. The results will then be chiefly of interest from the point of view of judgment statistics. So far as practical application is concerned, these results can only be said to point the way toward a more definite study of the variation of interest with the variation of the concrete object or commodity in the interest of which the appeal is made. Obviously the arguments which might tend to make a piece of jewelry desirable in the mind of a prospective customer might not be effectively used in the advertising of soap on the one hand or of insurance policies on the other. For each commodity there is probably a more or less definite and distinct set of appeals which is generally efficient. From the practical point of view it is important that each of these general types of commodity be investigated in its own right. Such studies are already in progress, and the results so far obtained have been compared with the actual keyed results of the appeals when they have appeared before the public. It is exceedingly interesting to know that the three such studies already made by the writer of the measurements of persuasiveness, according to the above described introspective laboratory method, have tallied closely with the pulling power of the separate compositions when they are rated according to the keyed results, thus testifying to the validity of the method and to its usefulness for practical purposes. A fuller account of these experiments is to appear in a forthcoming book on *The Principles of Appeal and Response*.

Certain sources of error in such an experiment are at once obvious.

1. It is difficult to keep out of even these abstract appeals some suggestion of special reference. Thus the appeal to *appetite* will inevitably suggest food; some *health* appeals are strikingly medicinal in tone; and doubtless in most cases

there is a more or less pronounced tendency to think of one article rather than another.

2. There is a certain feeling of self consciousness and reserve in submitting honestly to such an experiment, a tendency to place low certain appeals which really bulk large outside of the laboratory, or a tendency towards ideal arrangement strongly suggestive of the inclination to give learned responses in association tests.

Of these two sources of error, it may be said that neither affects in any undesirable way, the character of the experiment as a study of judgment. From the practical point of view only the second error is of importance. And that the danger here is minimal is attested by the fact that the results of such tests are verified by the keyed results. The observers used were thirty women, mostly juniors in Barnard College, taking their second year's work in psychology, and twenty men in Columbia College of corresponding age and class. Twenty of the women made two arrangements, one month apart, without having meanwhile seen the cards. The other ten women and the twenty men made but one arrangement. No time limit was given. Each observer was allowed to work over the material until a satisfactory order had been secured.

Comparison of the two trials of the group of twenty women will thus throw light on the permanence of such judgments and on the consistency of different individuals. Comparison of this group with the group of ten women will show how far the average judgments of such an experiment are typical of the results to be expected from observers of approximately the same class. Comparison of the group of men with the women will reveal such sex differences in these traits as may be present. Separate study of each group will show the degree of variability introduced by the personal equations of the various observers, the general relationships of individual judgments to group averages, etc. The array of figures yielded by such an experiment is a veritable mine of suggestions and material. The chief coefficients of correlation for the present experiment are brought together in the following table.

TABLE I

COEFFICIENTS OF CORRELATION

$$r = 1 - \frac{6\Sigma(d^2)}{n(n^2 - 1)}$$

	Final Average Positions		P.E.
1	20 women with 20 men, one trial	+.624	.06
2	10 women with 20 men, one trial	+.598	.06
3	20 women with 10 women, one trial	+.610	.06
4	20 women, first and second trials	+.903	.02
5	Av. r of girls, first and second trials	+.677	.05
6	Median r of girls, first and second trials	+.719	.05
7	Av. r of 20 girls with average of group	+.432	.08
8	Median r of 20 girls with average of group	+.480	.07
9	Av. of 20 men with average of group	+.588	.06
10	Median of 20 men with average of group	+.610	.06
11	r between agreement with group av. and personal consistency of 20 women	+.285	.12
12	r of final pos. of 50 cards by the method of av. with method of median, 20 women, first trial	+.947	.02
13	r of M.V.'s for the 50 cards	+.743	.04
14	20 women, first and second trials	+.743	.04
15	20 women and 10 women	+.310	.08
16	20 women and 20 men	+.130	.13
17	Av. M.V. of 20 women, first trial	10.8 places.	
18	Av. M.V. of 20 women, second trial	10.6 places.	
19	Av. M.V. of 10 women, first trial	10.5 places.	
20	Av. M.V. of 20 men, first trial	10.9 places.	

TABLE II

Average M.V.'s of	Best 10	Middle 10	Poorest 10
20 women (1st)	10.10	11.18	10.07
20 women (2d)	9.76	11.93	9.59
10 women	9.37	10.58	8.77
Av. women	9.74	11.23	9.47
20 men	9.84	12.96	10.79
Grand average	9.76	11.44	9.80

ANALYSIS OF THE JUDGMENTS

Coefficients 1, 2 and 3 (Table I.) show the degree to which the final average order of the 50 appeals as judged by one group of observers correlates with the order of the same series according to the average judgments of each of the other two groups. The three coefficients are strikingly equal, being .62, .60 and .61, for 20 women with 20 men, 10 women with 20 men, and 20 women with 10 women. It seems safe to conclude that a coefficient of about + .60 is a fair measure of the likelihood that the results from one group will coincide or confirm the

TABLE III

INDIVIDUAL COEFFICIENTS

Observers	Women		Men
	r with Group Average	r First and Second	r with Group Average
1	+.660	+.808	+.743
2	+.626	.713	.730
3	+.620	.756	.680
4	+.620	.739	.677
5	+.575	.743	.676
6	+.552	.781	.675
7	+.530	.654	.660
8	+.520	.780	.656
9	+.512	.526	.640
10	+.510	.600	.617
11	+.451	.591	.600
12	+.439	.893	.572
13	+.430	.725	.525
14	+.358	.127	.524
15	+.355	.874	.513
16	+.347	.681	.510
17	+.241	.553	.467
18	+.216	.529	.460
19	+.214	.763	.422
20	−.130	.712	.400
Average.	+.432	+.677	+.588
Median.	+.480	+.719	+.610
	r=+.285		

results from another. No sex difference seems to be present, so far as final average rating of the appeals is concerned. The group of 20 women correlate equally well with a group of 20 men and with another group of women while the men correlate about as high with the one group of women as with other.

As compared with this rather low correlation, the two successive trials, a month apart, made by the group of 20 women, yield a high coefficient. Correlating the final average positions of the 50 cards in the two trials gives + .90 (no. 4). This indicates that the average judgment of a given group is rather a stable and significant thing, and is characteristic of that group over a considerable period of time. For single individuals, however, the coefficients are variable, the personal consistency coefficients of the group of 20 ranging for the most part from + .53 to + .89, with one case as low as + .13. This is however the only case that is below + .53. The average

is + .68 and the median + .72. The coefficient for the same individuals' personal consistency thus stands about midway between that of the consistency of a group average and the agreement of the two diverse groups. (See coefficients 4, 5, 6.)

Another set of measurements of interest is found in the figures which show the approximation of the individual's judgments to the average judgment of his group. Coefficients 7, 8, 9, 10 give these figures for the two groups of 20, and Table III. gives the figure for each individual in both groups. The coefficients for the women range between −.13 and + .66 thus giving a total range of + .79, with the average at + .48. For the men the coefficients cover a much narrower range, varying between + .40 and + .74, thus a total range of only 34., a range only 43 per cent. as large as that of the women. The average for men is + .59, the median + .61 being thus about 25 per cent. higher than the same for women. Only 4 women exceed the median for men, while all but 4 men exceed the median for women.

Both of these facts, that of higher correlation and that of narrower range, point in the same direction—viz., toward the greater homogeneity of the group of men. The high coefficients indicate that any one man selected at random will be a better example of the characteristics of his group than will a similarly selected woman of her group. And the narrow range again indicates the tendency of the men, not only to depart but slightly from the type but also to depart in approximately equal degrees from it. Whether these facts point to a greater general variability of women as compared with men, or only to the particular composition of the two groups taking part in this experiment one can not say. But the present method seems to indicate a concrete and interesting way of studying this much disputed question of the relative variability of the sexes, in what may be called the higher mental processes.

A question that has frequently been raised in such studies is that concerning what might be called general judicial capacity. Does the individual whose personal consistency is greatest show any closer approximation to the average of

his group than does the individual whose personal consistency is low? The writer has already presented data on this point[1] indicating that the probability of such general capacity is low. The present study points in the same direction. The correlation between personal consistency and approximation to group average (see Table I.) is only + .29 with a P.E. .12. It seems fair to conclude that such general judicial capacity, when it does show itself, is either accidental or due to the quality of the material used.[2]

The averages of the M.V.'s for the 50 appeals as arranged by the separate groups are strikingly constant, being 10.8, and 10.6, 10.5, and 10.9 places for the 20 women, 10 women and 20 men respectively. That is to say, when the total number of possible positions is 50, the average M.V. is 10, or about one fifth the total range. This would mean, as the writer has previously shown in detail,[3] that only about four degrees of persuasiveness can be given on which the judgment of the group as conditioned by the probable error, would agree. The result here clearly justifies the conclusion reached in the previous study.

In Table I. (coefficients 18, 19, 20) are given the correlations between the magnitudes of the M.V.'s for the separate appeals as judged by the different groups. These figures show how far there is identity in the appeals over which the various individuals of the separate groups differ. Thus for the two trials of the group of 20 women, this coefficient is + .74, showing that the group disagree over the same cards in both trials, and indicating the permanence of the factors on which the M.V. depends, *i. e.*, the specific individual differences. This point is of course farther shown by the high personal consistency coefficients.

But correlating the group of 20 women with the group of 10 women gives a coefficient of only + .31 indicating that the agreements and differences are not common to the two

[1] See 'Judgments of the Comic.' PSYCHOL. REVIEW, March, 1911, pp. 132–156.

[2] See Wells, 'On the Variability of Individual Judgments.'—Essays Psychological and Philosophical in Honor of Wm. James, pp. 511–549.

[3] See 'Judgments of the Comic.'

groups. Comparing the 20 women with the 20 men shows an even lower correlation of only +.13. This means that the women on the whole tend to disagree over one set of appeals and that these are not the same appeals as those over which the men disagree. Just what the difference between the two sets is will be shown later.

A final point in the study of these records or judgments is the question of closeness of agreement at the top of the list, among the preferences, as compared with that at the bottom of the series, among the dislikes. The evidence here, as presented in Table III., is suggestive. Women seem to agree more closely on their dislikes (M.V. 9.4) than on their preferences (M.V. 9.7), but the difference is not large. It is probably reliable and genuine, however, since the relation holds in all three experiments with women. The men, on the other hand, agree more closely on their preferences (M.V. 9.8 as against 10.8 for dislikes) and the difference is considerable. The averages of men and women show no difference whatever, being 9.76 and 9.80. There seems to be a real sex difference here, which, expressed in general terms would be, that men resemble each other more closely in their preferences, while women are more alike with respect to their aversions. This fact throws some light on the previous finding that there is low correlation between the magnitude of the M.V.'s for the particular cards when the variabilities of the women's judgments are compared with those judgments passed by the men.

Applications

Turning now from the study of the judgments themselves and examining the appeals on which the various judgments are passed, a mass of interesting information results. These results, from the point of view of the applied psychologist, merit discussion in detail. In the present paper, however, we must limit ourselves to giving the various tables of measures and briefly summarizing their meaning.

Table IV. gives a statement of the relative persuasiveness of the different appeals for men and women,—their average values and positions. In this table the various cards which

TABLE IV

RELATIVE PERSUASIVENESS FOR MEN AND WOMEN

Appeal	No.	40 Final		20 Women		20 Men	
		Av.	Pos.	Av.	Pos.	Av.	Pos.
Health	3	4.0	1	5.0	2	3.0	1
Cleanliness	1	4.0	2	5.0	3	3.0	2
Scientific	2	6.5	3	6.5	5	7.0	5
Time saved	1	8.5	4	3.0	1	14.0	10
Appetizing	1	9.0	5	13.0	8	5.0	3
Efficiency	3	9.3	6	5.3	4	13.3	9
Safety	4	10.5	7	15.7	11	5.2	4
Durability	2	11.5	8	8.5	6	14.0	11
Quality	2	14.5	9½	10.0	7	19.0	13
Modernity	2	14.5	9½	16.5	12	12.5	8
Family affection	4	15.2	11	21.8	15	8.7	6
Reputation	5	21.1	12	18.4	13	23.8	15
Guarantee	2	21.2	13	14.5	9	28.0	19
Sympathy	1	23.0	14	37.0	23	9.0	7
Medicinal	3	25.0	15	15.0	10	35.0	22
Imitation	3	25.5	16	30.0	19	21.0	14
Elegance	2	26.0	17	34.0	22	19.5	12
Courtesy	1	26.0	18	27.0	17	25.0	16
Economy	5	26.4	19	27.6	18	25.2	17
Affirmation	2	29.0	20	30.0	20	28.0	20
Sport	2	29.0	21	32.5	21	25.5	18
Hospitality	1	29.0	22	24.0	16	34.0	21
Substitutes	1	34.5	23	21.0	14	48.0	28
Clean feeling	4	41.0	24	40.5	24	41.5	25
Nobby	2	42.5	25	47.5	28	37.5	23
Recommendation	2	43.0	26	48.0	29	38.0	24
Social superiority	4	44.0	27	41.2	25	47.0	27
Imported	1	45.5	28	45.0	27	46.0	26
Beauty	3	45.8	29	43.0	26	48.7	29

might be classed under one general heading, such as health, reputation, economy, etc., have been grouped and their average taken as representing the most probable values, of this type of appeal. The second column in the table gives, for each general type, the number of actual cards averaged to give the result found in the table. Since this number varies from 1 to 5, the reliability of the various measures is not uniform.

Columns 3 and 4 give the final averages and positions for the combined groups of 20 men and 20 women. The values range from 4 to 45.8, these numbers indicating the average positions in the list of 50 possible places. The group of appeals, as a whole, falls into three rather sharply defined sections, the series breaking at values 15.2 and at 29.0 at which

points there are wide gaps, which contrast with the gradual transitions of value within the groups. And these sections, moreover, correspond to qualitatively different groups of appeals.

In the first group, with values ranging from 4.0 to 15.2 fall the appeals to health, cleanliness, scientific construction, economy of time, appetite, increase of efficiency, safety, durability, quality, modernity, and family affection. The general characteristic of these appeals is that they are strictly relevant in tone, describe the article precisely or point out some specific value, quality or 'selling point' which it possesses.

In the second group, with values ranging from 21.0 to 29.0, fall the appeals based on the general reputation, guarantee or assertion of the manufacturer, and on a set of semi-irrelevant and more or less social feelings and interests, such as sympathy for others (not family), courtesy, imitation, elegance, hospitality, sport, cheapness, etc. The characteristic of these appeals is that they do not relevantly describe the article but try to connect it with some specific instinct or effective conception. And these appeals are distinctly less personal, more social, than those of the first group.

In the third section, with values ranging (with one exception) from 41.0 to 45.8, fall the rather vague appeals to avoid substitutes, to civic pride and clan-feeling, social superiority, recommendation, the ideals of fashion, foreign origin and finally the beauty appeal. The chief characteristic of this group seems to be that while, as in the second group the statement is semi-irrelevant or incidental, the feeling appealed to is indeterminate and general.

The only considerable sex differences, cases in which the difference in position is say five places or over, appear in the appeals entitled appetite, safety, 'nobby,' family affection, sympathy, elegance and recommendation, which are placed higher by the men; and on time saved, guarantee, medicinal, subsitutes, efficiency, durability, quality and hospitality which are placed higher by the women.

Table V. gives the ten appeals whose M.V. for women is only 9 places or less in both trials, and Table VI. the 7 on

TABLE V

APPEALS WHOSE M.V. FOR WOMEN IS ONLY 9.0 PLACES OR LESS, FOR BOTH TRIALS

Cards	Appeal	M.V.	
		Women	Men
1B	Style	5.8	7.5
1D	Nobby	7.3	10.3
1F	Sanitary	7.7	10.5
1N	Appetizing	8.9	8.8
1O	Social standing	9.0	12.6
1T	Time saved	8.6	12.2
1V	Safety	8.9	9.9
1W	Durability	8.2	8.0
2O	Necessity	8.2	14.0
2R	Economy	8.0	7.3
Averages		8.0	10.1

TABLE VI.

APPEALS WHOSE M.V. FOR MEN IS ONLY 9.0 PLACES OR LESS

Card	Appeal	M.V.	
		Women	Men
1B	Style	5.8	7.5
1K	Scientific	9.1	8.4
1N	Appetite	8.9	8.8
1W	Durability	8.2	8.0
2B	Family affection	13.5	7.7
2L	Evolution	10.9	9.0
2R	Economy	8.0	7.3
Averages		9.2	8.1

which the M.V. for men is 9 places or less. These are the appeals on which the numbers of the respective groups agree closely. These appeals are about the same for both sexes. Both tables give the M.V.'s for both men and women for each card. While the final average M.V. for the 50 appeals is the same for women and men, there is considerable difference in the comparative averages of the cards included in these two tables. The men's M.V. (10.1) for cards on which the women agree is greater than the M.V. (8.0) of the women and also greater than the M.V. (8.1) of the men themselves on the cards where their own agreement is close (9.0 or less). The same holds for the women. Their M.V. (9.2) for cards where men agree most closely is greater than the M.V. (8.1) of the men on these cards and also greater than their own M.V.

(8.0) on cards over which they themselves agree closely (9.0 or under).

Whereas the agreements of the two groups (men and women) fall on much the same appeals, the great disagreements fall on different cards. Table VII. shows the cards on which

TABLE VII

APPEALS WHOSE M.V. FOR WOMEN IS OVER 12 PLACES IN BOTH TRIALS

Cards	Appeal	M.V.	
		Women	Men
1E	Popular	13.2	9.9
1H	Patriotism	15.6	10.3
1M	Caruso	14.0	14.5
1V	Reputation	12.8	12.0
2B	Family affection	13.5	7.7
2D	Efficiency	12.8	13.7
2E	Guarantee	12.7	11.4
2G	Union made	14.6	11.6
2K	Civic pride	15.0	10.3
2Q	Sympathy	15.3	9.9
2S	Enormous	14.6	11.4
2T	Growth	16.3	11.5
Averages		14.2	11.1

TABLE VIII

APPEALS WHOSE M.V. FOR MEN IS OVER 12 PLACES

Cards	Appeal	M.V.	
		Women	Men
1C	Health	10.9	15.6
1L	Royalty	8.5	12.1
1M	Recommendation	14.0	14.5
1O	Social standing	9.0	12.6
1T	Time saved	8.6	12.2
2C	Ambition	10.9	13.5
2D	Efficiency	12.8	13.7
2M	Excel	11.7	13.0
2O	Necessary	8.2	14.0
2P	Progress	11.7	12.3
2F	Youth	8.9	13.1
Average		10.4	13.3

the M.V. for women is 12 places or over in both trials, and Table VIII. the same for men. Both tables give the M.V.'s for each card for both sexes. The disagreement of women fall on appeals to rather general *social* feelings,—patriotism,

popularity, family provision, civic pride, sympathy, union made, recommendation, reputation, etc.—feelings and impulses the absence of which would make social solidarity impossible. On these appeals the men agree (M.V. equals 11.1) much more closely than the women (M.V. 14.2).

The men however disagree over more *personal* appeals, such as efficiency, ambition, economy of time, health, social standing, progressiveness, etc., with an average M.V. of 13.3. But here the women agree more closely, M.V. 10.4. Here again women differ less (10.4) than men (13.3) on men's 'disagreement cards' and much less than on their own 'disagreement cards' (14.2). Men differ (11.1) less than women (14.2) on women's 'disagreement cards' and also less than they do on their own agreements (13.3).

The group of men and the group of women are thus seen to be homogeneous, but the basis of this homogeneity in the two groups is not the same. The men tend to be homogeneous on the basis of social, solidarity appeals, the women on the basis of personal appeals. The greatest individual differences among the men, that is to say, are on the *personal* appeals, the greatest differences among the women on the *social* appeals. Here again is an interesting suggestion, but whether it bears in the direction of selection and sex experience, or toward the temporary motives which operate in such an experiment, cannot be known at this point.

Turn now from the M.V.'s of the separate groups and consider the cases in which the final average judgments of the two groups (men and women) agree closely (within 5 places or less). Table IX. gives the 15 appeals in which this is the case, the + sign indicating that the card was placed higher by the men. These cards fall sharply into two groups, —A, a group of eight which both men and women place high, in the upper third of the range, varying from 1 to 15 with median at 6.5, and B, a group of seven, falling for the most part in the lower third, all but two (25 and 26) being beyond 30 for both men and women, and the median being at 46.0. Which is to say, just as the M.V.'s of a given group tend, in such an order of merit experiment, to be smaller at the

top and bottom of the series than in the middle range, so these two groups agree closely on the strongest and weakest appeals.

Table IX

Cards Showing a Difference of only 5 Places or Less in the Final Orders for Men and Women. Men Higher=+

Card	Av. Pos.	Appeal	
1K	1	Scientific.	
1W	2	Durability.	
1F	3	Sanity	+
2D	4	Efficiency.	
2L	9	Evolution.	
2R	14	Economy.	
2F	11	Safety	+
1Q	15	Child love	+
2W	25	Middlemen.	
2Z	26	Courtesy	+
2V	31	Hunting	+
2N	46	Admiration.	
2H	47	Imported.	
2A	49	Personality.	
2Y	50	Youth.	

Table X

Cards Showing a Difference of 15 or more Places in the Final Orders for Men and Women. Men Higher=+

Card	Av. Pos.	Appeal	
1C	20	Health.	
1P	27	Stimulating.	
2B	6	Family affection	+
2T	28	Growth.	
2J	36	Genuine.	
1V	16	Safety	+
1E	17	Popular	+
1A	21	Elegance	+
2Q	23	Sympathy	+
2G	41	Union made	+
	22 =	Median.	

Do the two groups then differ considerably on their estimates of the cards which tend to fall into the central range as shown by the average judgment of both groups? Table X. shows the ten cards on which this difference is 15 places or more. The median of these cards is at 22±7.5, which means that these cards occupy the middle section of the range.

Just as the repeated judgments of the same individual, and the judgments of the individuals of a group, are more variable in the middle of the scale, so we find that the large differences in the final order for the two groups fall in the middle section.

Column four of Table X. indicates by the + sign the appeal for the "15 or more" cards placed higher by the men than by the women, and by the absence of any mark, the cards placed correspondingly higher by women. We have already seen (Table VIII.) that the men agree most closely on appeals to interests making for social solidarity. The present table shows that the men not only *agree more closely* on these appeals than do the women, but agree also in *placing them higher* in the scale of persuasiveness.

Summary

By way of summary we may say briefly:

1. The judgment of persuasiveness lends itself to concrete measurement and shows certain characteristic constancies and tendencies from individual to individual and from group to group.

2. Such measurements tally with the actual keyed results of the appeals when used as advertising copy.

3. The final orders of strength of appeal as judged by various random groups of observers, correlate with each other with a quite constant coefficient of + .60.

24. The median coefficient indicating the personal consistency of an individual stands about midway between the consistency of a group average and the agreement of two diverse groups.

5. Men correlate with their group average about 25 per cent. more closely than women.

6. The range of variability in the above coefficient is for men only 43 per cent. as large as for women.

7. The correlation between personal consistency and approximation to group average, or what may be called the measure of general judicial capacity, is in such an experiment low, $r = .29$, with P.E. = .12.

8. The average M.V. for all four groups is in this, as in most order of merit experiments in which the judgment is based on general impression, about one fifth the total possible number of positions.

9. A sex difference shows itself in the experiment with respect to the appeals concerning which group judgments agree or disagree. Men agree more closely in their preferences while women are more alike in their dislikes.

10. Generally speaking, the most persuasive appeals are reported to be those presenting strictly relevant descriptions, specific values, qualities or 'selling points.' Next come appeals to specific interests, instincts, feelings and effective conceptions, and finally appeals of a general, incidental or semi-irrelevant kind.

11. Women as a group are more homogeneous when judging the strength of *personal* appeals, but show considerable individual differences in judging appeals made to the instincts or impulses underlying *social* solidarity.

12. Men tend to reverse this relation, being homogeneous where women differ and disagreeing most where women agree.

FROM THE UNIVERSITY OF CALIFORNIA PSYCHOLOGICAL LABORATORY

XIV. The Psychology of Change: on Some Phases of Minimal Time by Sight

BY JOHN M. BREWER, B.S.

The present paper is concerned with the description of an experiment that attempts to bring nearer the answer to the following questions: (1) What is the smallest time-interval between two successive lights when the lights are seen to come not simultaneously but in succession? (2) What is the smallest extent of time that a motion can last, and still be perceived as motion? And the investigation of these two questions, with the hope of bringing out some connection or disconnection of the one group of facts with the other, was confined to a special set of conditions; namely, that in which the two points whose succession or simultaneity is to be observed, are not in absolute juxtaposition but are appreciably apart, and where the space-interval between them is varied as we pass from group to group of experiments. For it seemed an open question whether an advantage that might accrue, let us say, to either motion or succession, when one space-interval was involved, would also be maintained with a different interval of space.

The subject, in a somewhat darkened room, was placed 360 cm. distant from a large screen bearing a narrow vertical slit that could, for the sake of proper fixation, be dimly seen. And in this position he saw either two lights in succession, one directly above the other, or else a moving point of light. These were produced in the following way. Behind the screen and directly in line with the slit was a surface evenly lighted by an electric light; and between screen and lighted surface swung a pendulum, bearing a wide sheet of metal, set into which were devices for producing the appearances

described above. For giving an appearance of succession two small apertures were cut in separate slides that were in reality circular arcs so arranged that the apertures would pass the slit with a varying intervening time, yet with no varying of their distance from the point of suspension of the pendulum; and consequently for any given set of experiments they presented to the observer always the same angular, or vertical, separation. Yet in the different sets of experiments the amount of their vertical separation differed, being respectively 7, 10 and 19.5 mm., or, expressed in angular measure, 6.7′, 9.5′ and 18.6′ of arc.

Instead of the appearance of succession, it was possible to offer an appearance of motion by substituting for the apertures just described a circular card that could be moved at will about its own center. In this circular card there was a narrow slit; and by different settings of the card its slit could be placed at any angle to the slit in the stationary screen immediately before it; and consequently there was presented to the observer the appearance of a point of light moving either up or down. The extent of the motion up and down was carefully limited by opaque surfaces above and below, and made to correspond, in the three parts of the experiment, with the spatial angles above mentioned: 6.7′, 9.5′ and 18.6′. The velocity of the apparent movement, of course, varied step by step with the shifts in the angle of the pendulum slit. The swing of the pendulum was kept constant by the use of magnets, and its speed in the vicinity of the center was carefully calibrated by means of a tuning-fork.

In determining the thresholds for the different orders of stimulation, the method of serial groups[1] was used, 'no-interval' cases being intermixed about equally with the intervals whose thresholds were sought. The threshold was crossed after the manner of the method of minimal changes, and for both orders of sequence (viz., upper light first, and lower light first), and of motion (viz., downward and upward). Each value in Tables I.–III. is then an average of four

[1] See 'Studies from the Univ. of Calif. Lab., IV.,' PSYCHOL. REVIEW, IX., 1902, 444.

'determinations' and into each determination there enter forty to fifty experiments. And since it was often the case that an observer could tell that the lights came at different times, but could not tell which came first, or observed motion, though he could not tell its direction, the two kinds of threshold are here recorded separately—the threshold for the

TABLE I

THRESHOLDS, EXPRESSED IN σ, FOR VISUAL ANGLE 6.7′

Observer.	With Discrete Sequence.		With Motion.	
	Judg. of Succession Merely.	Judg. of Order of Succession.	Judg. of Motion Merely.	Judg. of Direction of Motion.
B	22	29	29	31
L	22	22	21	21
M	54	60	48	48
S	20	22	30	32
W	33	43	22	30

TABLE II

THRESHOLDS, EXPRESSED IN σ, FOR VISUAL ANGLE 9.5′

Observer.	With Discrete Sequence.		With Motion.	
	Judg. of Succession Merely.	Judg. of Order of Succession.	Judg. of Motion Merely.	Judg. of Direction of Motion.
B	22	30	22	22
L	32	32	19	19
M	58	61	33	33
S	35	35	28	32
W	33	33	21	21

TABLE III

THRESHOLDS, EXPRESSED IN σ, FOR VISUAL ANGLE 18.6′

Observer.	With Discrete Sequence.		With Motion.	
	Judg. of Succession Merely.	Judg. of Order of Succession.	Judg. of Motion Merely.	Judg. of Direction of Motion.
B	37	39	30	30
L	28	30	20	20
M	53	60	76	76
S	45	45	24	24
W	43	52	20	20

bare perception of the succession or motion, and that for the definite order of the succession or for the direction of motion. It should be said that the subjective appearance of motion, which Exner noticed, did not appear to any important

extent in making these determinations. Only one subject had this illusion, and he for a very short time only. The results are stated in thousandths of a second.

There is in many cases, as these tables show, a lower threshold when motion is offered than when there is offered discrete sequence. In the thirty pairs of values that are comparable in this respect, twenty-one show a clear advantage for motion. Yet in none of these pairs is there any such advantage as Exner noted. Moreover, it is evident that the smallest visual angle is for the greater number of the observers the most favorable of the three for the perception of the discrete sequence, whether the judgment passed be of sequence merely or be of the order of the sequence. The separation of the lights would here seem to be sufficient to prevent at least any troublesome degree of overlapping of the irradiation circles upon the retina, and at the same time not so great as to render comparison difficult. At the angle 9.5′, such comparison seems already to have become harder and at 18.6′ harder still. For the perception of motion, however, the most favorable space extent for most of the observers was neither the shortest nor yet the longest of the three employed, but the middle distance. Motion through the angle 6.7′ seems to have been too short to be most readily seen as motion; while with the angle 18.6′ there evidently was again some difficulty, though of a different kind and greater—that again prevented the distance from being optimal.

Some idea of the comparative advantages of the different angular extents may be gained from the following table wherein the thresholds for the different orders of perception are stated in the form of averages of the time obtained for all five of the observers.

TABLE IV

AVERAGE THRESHOLDS, EXPRESSED IN σ, FOR THE THREE VISUAL ANGLES

Character of Change Presented.	Visual Angle 6.7′.		Visual Angle 9.5′.		Visual Angle 18.6′.	
	Judg. of Occurrence Merely.	Judg. of Order or Direction of Occurrence.	Judg. of Occurrence Merely.	Judg. of Order or Direction of Occurrence.	Judg. of Occurrence Merely.	Judg. of Order or Direction of Occurrecne.
Discrete sequence	30	35	36	38	41	45
Actual motion	30	32	25	26	34	34

So far as discrete sequence is concerned, there are, however, exceptional observers, like M, who reveal no great difference as we pass from one visual angle to another; or, like B and W, for whom 6.7′ and 9.5′ are practically alike, while 18.6′ shows a distinct disadvantage. And, again, in the region of motion, the general advantage possessed by the medium extent 9.5′ practically disappears with the observer W for whom there is, if anything, a very slight drop in the thresholds as we pass out to the very largest angle, that of 18.6′; and with another observer, S, this same tendency is even more clear, and the longest distance, 18.6′, is now the most favorable of all. Yet the departure of these observers from the precise relations found with their fellows permits one still to say that there is in general in shorter space-extents a condition *favorable* to the perception of discrete sequence, and yet *unfavorable* to the perception of motion. And while the most favorable extent here used for perceiving discrete sequence gives, on the average, a minimal threshold of 30σ, the most favorable extent for perceiving motion gives a threshold of 25σ; the threshold for the perception of discrete sequence is thus about one fifth higher than that for motion. This, however, shows that at least under the peculiar conditions of the present experiment, there is a considerable departure from the relation which Exner believed to exist, namely, that the time-threshold for the perception of succession is about three times as high as that for the perception of motion.

XV. The Psychology of Change: How is the Perception of Movement Related to that of Succession?

BY G. M. STRATTON

The experiments to be described deal with a narrow margin of that wide process by which we are conscious of change. For even with all the interest that has in past years been shown in this complex act, one can hardly say that there is as yet any general agreement as to its inner character or as to its outer connections. It has repeatedly been asserted that change is, at its best, caught by us directly and simply; that when we notice some sudden brightening of a light or damping of a sound or increase of pain or shift of place, the change-experience itself is of a unique quality, like the taste of bitter or the sight of blue, and that at such times the process has all the marks of a sensation. The detection of change, it is held, involves at such times no comparison, no overspanning consciousness that now the object is in one state or condition and now in another, but we become aware of the change in a single and simple throb of mind. And all this has been denied.

In the case of visual movement, to be more specific—for with visual movement alone the present experiments are concerned—orthodox belief has been that there is always present a double act of discrimination, at once of instants and of positions; against which is the belief that the retina is directly responsive to rapid movements of light, and that the movement is perceived without any such complex dealing at once with space and time. The idea of an absolutely direct and simple sensory appreciation of motion suggested by Czermak[1] and to some extent furthered by Vierordt,[2] found a strong

[1] 'Ideen zu einer Lehre von Zeitsinn,' *Sitzungsb. d. kaiserl. Akad. d. wiss. Math.-Naturwiss. Cl.*, Vol. 24 (Vienna, 1857), pp. 231–236.

[2] 'Der Zeitsinn nach Versuchen,' 1868; cf. especially pp. 114 f., where Vierordt says that in perceiving motion both the time-sense and the space-sense are required, but that the processes involving space and time cease to arise clearly in consciousness because they run so smoothly and habit-like, and so the whole takes on a quasi-sensory character. Accordingly, says he, we may as justly use the expression *Geschwindigkeitsempfindungen* as *Zeit- und Raumgrössenempfindungen*.

supporter in Exner, whose argument rests upon two kinds of experimental observation, in the region of space and of time respectively. In regard to space, rapid motion can be discerned, he held, within limits too narrow for space-discrimination; a small disk of light can be seen to move even when its excursion is considerably less than the distance between two such disks of light that, when stationary, already appear as one. *Consequently* (we may paraphrase his argument) *space-discrimination cannot be an essential part of the process of perceiving motion*, at least when rapid. Furthermore, and now passing over into the region of time, motion can be seen as motion even when its duration is far less than the least time that permits us to notice succession. If instead of making the excursion through a shorter and shorter distance, the extent of the excursion remain constant and the movement be made more and more *rapid*, Exner found that, even when the motion occupied a time so brief that two sparks, the one at the beginning, the other at the end of such duration, seemed absolutely simultaneous, the motion was still perceptibly motion. *Consequently* (so runs the thought) *time-discrimination cannot be an essential part of the process of perceiving motion.*[1]

As regards the first part of this argument—the part that deals with space-discrimination—I may perhaps refer to experimental evidence already offered by myself tending strongly (so it seems to me) to show that the facts upon which the argument is based were gathered far too narrowly.[2] If, instead of relying on the two-point method of determining the space-threshold, we employ a method involving the apparent dislocation or coincidence of two parallel lines placed end to end, the power to detect differences of position is approximately the same as that for the perception of movement. And consequently a full half of the ground for believing in the psychic simplicity and independence of movement caves away.

[1] Cf. the argument as set forth in James's *Principles of Psychology*, II., 172. The refs. to Exner are found below.

[2] 'Visible Motion and the Space-threshold,' PSYCHOLOGICAL REVIEW, IX., 433 ff.; and cf. Bourdon: *La perception visuelle de l'espace*, pp. 144 f., with the refs. there given.

I. Previous Experimental Work

Exner's experiments upon the time-factor in the perception of visual movement were in substance as follows.[1] Using close-neighboring electric-sparks, he found that with eyes at a certain distance from the sparks the most rapid succession that could be discerned was one of 44σ. But by more than doubling the distance between eye and sparks and thus proportionately diminishing the visual angle between the sparks and at the same time producing an illusion of movement from one to the other, he found this movement still noticeable when the time-interval was shortened by practice to 15σ. Substituting for the electric sparks flashes of light through two apertures in a screen, Exner could tell correctly the order of sequence when the flashes were 45σ apart; but when the portion of the screen between the two apertures was cut out and otherwise so arranged as to give a moving light between these two localities, motion could still be perceived when its duration was but 14σ. Motion, whether real or apparent, thus had power, it seemed, to reduce the limit below which a visual stretch of brightness appeared as a synchronous and uniform illumination. Exner's data for this conclusion were obtained from foveal vision; with eccentric vision he found it impracticable to exclude the appearance of motion; he was thus unable to compare in this region the times of just-visible motion and of succession apart from movement.

Charpentier, who next in any significant way approached the problem, employed a method much the same as the second of Exner's described above, yet with this important difference, —that instead of producing discrete succession by separated, although neighboring spots of light, he arranged a vertical slit, of which he could illuminate independently the upper and the lower half, and thus the sensations whose sequence or simultaneity was to be caught appeared in absolute juxtaposition. He found: (1) that if the time-interval between the halves be slight, they seem illuminated simultaneously;

[1] Exner, 'Experimentelle Untersuchung der einfachster psychischen Processe Pflüger's *Archiv*, VII., 601 ff.; VIII., 526 ff.; XI., 403 ff.; 'Ueber das Sehen von Bewegungen und die Theorie des zusammengesetzten Auges,' *Sitzungsb. d. kaiserl. Akad. d. Wissens. Math.-Naturw. Cl.*, LXXII., Pt. III (Vienna, 1875), pp. 156 ff.

(2) with increase of this interval the illuminations seem distinct in time, but it is impossible to say which comes first; (3) only with still greater increase of the time-interval can one say which is first; and (4) the absolute duration of the illumination of each half seems not to affect this detection of sequence. On the average (and apparently from but a few experiments) he found a noticeable difference when the beginnings of the lights differed by 27σ.[1] With regard to Charpentier's discussion of the error we make in the appreciation of succession—the illusion that successive lights are simultaneous—it was contended by Bloch that this error entirely disappears if the successive stimulations do not fall upon identical parts of the retina,[2]—a surprising criticism, apparently based neither on any right understanding of Charpentier nor upon any reliable experiment of Bloch's own. Charpentier, in reply,[3] after clearing up the matter of method, says briefly and with restraint, that while he cannot deny that the succession may continue to appear to the very end, he is quite unable to notice it himself. Neither Charpentier nor Bloch seem to have made more than a few trials nor to have concerned themselves with obtaining comparable data in the region of movement, and so of clearing up the problem more directly before us.

This problem was, however, held distinctly in mind by Stern,[4] who arrives at a conclusion opposed to that of Exner. But since his own experimental contribution is confined to the spatial rather than to the temporal side of the question,[5] it hardly need here be reproduced.

[1] Charpentier, 'Sur l'appréciation du temps par la rétine,' *Séance et Memoires de la Societé de Biologie*, Vol. IV., 8th Series (Paris, 1887), pp. 360–1; 'Nouvelle note sur l'appréciation du temps par la rétine,' *ibid.*, pp. 373–5.

[2] Bloch, 'Note sur les sensations visuelles,' *ibid.*, pp. 391–3.

[3] Charpentier, 'Note sur le synchronisme apparent,' etc., *ibid.*, pp. 447–8.

[4] 'Die Wahrnehmung von Bewegungen vermittelst des Auges,' *Zeitschrift für Psychologie*, etc., VII. (1894), 321 ff. Stern is in the neighborhood of the time-side of the problem only when he considers the most favorable *rhythm* of motion if the motion is to be noticed. Cf. my own discussion and opposing results, in 'Visible Motion and the Space Threshold,' PSYCHOLOGICAL REVIEW, IX., 433 ff.

[5] This is true also of the work of Basler, 'Ueber das Sehen von Bewegungen,' Pflüger's *Archiv*, 1906, XV., 582, 1908; CXXIV., 313.

Weyer, experimenting with successive electric sparks, given (it would seem) from a single sparker and consequently appearing at one identical point, brought out some interesting facts concerning the detection of sequence; but his interest was not directly in our problem, and he made no attempt to obtain in the field of movement data with which his results upon succession might be compared. He found, however, that in starting with so brief an interval that the two sparks appeared as one, there were certain definite intermediate stages before this appearance of precise singleness of spark yielded to a clear appearance of succession. The apparently unitary illumination began to drag, or 'persist' when the interval was somewhat increased—to about 12σ, with daylight adaptation. With still greater increase—to an interval of 25σ–30σ—there came a slight flicker. Finally, when the interval was increased to 43σ–53σ, the two sparks appeared in clear succession.[1]

With Bourdon there was distinct interest in our particular problem, and he accordingly gathered data both of succession and of movement. He used small areas of white paper attached to a revolving drum, so arranged that they produced an appearance now of motion and now of mere sequence of neighboring lights. When the conditions were on the whole most favorable, he found motion recognizable by direct vision at a duration of 27σ. With discrete succession instead of motion, he found it impossible to pass judgment when the interval was only 16σ; his right judgments exceeded the wrong when the interval was 20σ; when the interval was increased to 48σ, he recognized with certainty the *order* in which the lights disappeared. His conclusion is that the perception of motion has no such preëminence over that of succession as Exner claimed; indeed, the thresholds of these two kinds of perception come to nearly the same measure.[2]

[1] Weyer, 'Zeitschwellen gleichartiger und disparater Sinneseindrücke,' Wundt's *Philosophische Studien*, XIV., 616; XV., 67.

[2] Bourdon, *La perception visuelle de l'espace*, pp. 187 ff. Marbe (*Theorie der kinematographischen Projectionen*, 1910, p. 62) has added stlll later experiments, but again upon but one of the two sides important for the present question. He finds that when a series of 13 miniature incandescent lights flash in succession at a rate wherein the interval between the flashes of adjacent lights is reduced to 12σ the impression of movement ceases.

Only Exner and Bourdon, then, maintained in the two regions that must of necessity here be compared, a single unchanging method applied under inner and outer conditions that also in the main remained unchanged. And their excellent work, I have ventured to think, still leaves room, even apart from a certain conflict of outcome, for some doubt and inquiry. With Bourdon, for instance, it is clear that exactly the same conditions were not maintained both in his experiments upon succession and in those upon motion. The lines that passed the slit were not alike in the two cases; and this might have affected the apparent intensity of the sensations; the slit through which the stimulus appeared was, in the case of the motion, horizontal and 1 mm. wide, in the case of succession it was vertical and 0.4 mm. wide; the distance between the observer and the lights was different in the two cases. All these discrepancies should be removed, and the two series to be compared should run on abreast to avoid any possible advantage from the difference of training and practice. In particular it has seemed to me desirable to regard as an open question what the effect of certain variations of method would be; and farther, just what space relation should subsist between the successive lights, if the conditions were to be most favorable for the detection of succession. Will succession best be observed when the successive spots of light are closer together or farther apart; when they are in juxtaposition or when some distance intervenes? We should discover the most favorable conditions for each class of observations before we could finally decide as to their relative superiority.

It would be idle to claim that the programme finally adopted covers the ground; all that should be said is that it aims to clear up an obscure point or two. A part of it has been carried out by an able student of mine, Mr. Brewer,—the part dealing with successions that are not only temporally but spatially separate. And his report accompanies and may be regarded as an intimate part of this discussion.[1] His experiments had shown a regular reduction of the time-

[1] Brewer, *The Psychology of Change: On some Phases of Minimal Time by Sight*, in the present number of the PSYCHOLOGICAL REVIEW.

threshold for succession, as the visual angle was reduced. For myself, I felt tempted to push this reduction to its very limit by making trial, in the region of time, of a slight modification of method that has proved of marked effect in studying movement upon its spatial side. For it will perhaps be remembered by some that a change in the manner of testing the space-threshold, whereby lines were placed end to end, instead of side by side, had reduced the space-threshold at least five-fold and perhaps ten-fold; had reduced it from a visual angle of 30″ with stars, or of 60″ if we keep to lines, to a visual angle of approximately 7″.[1] Here in placing the lines end to end, there is perfect proximity of the impressions to be compared, yet without the easy fusion which befalls lines side by side. An analogous procedure in the realm of time would be to have the succession of flashes come, not upon the same points of the retina where persistence of impression would conceal the time-interval, but upon adjacent points, yet neither with confusion by overlapping circles of irradiation nor with any insistent illusion of movement. This seemed attainable by means of a narrow slit, half of which should be lighted at one instant, and half at another,—the time-interval between these illuminations to be variable and definitely known. The plan, then, involved the method already employed briefly by Charpentier, and at the same time the gathering of exactly comparable data regarding movement.

II. Experiments with Pendulum Device

In the present experiments two different arrangements of apparatus were employed. The first group of experiments was with the pendulum described in Brewer's paper already mentioned;[2] but with attachments other than those he used. Imagine a plate of aluminum just above the pendulum's bob, lying in the plane of oscillation. In this plate and at about a distance of 1 m. from the point of suspension of the pendulum there was a vertical radial slit 5 cm. long, with a mean

[1] 'A New Determination of the Minimum Visibile,' Psychological Review, VII., 249; 'Visible Motion and the Space-Threshold,' Psychological Review, IX., 433 ff. Cf. Bourdon, *La perception visuelle de l'espace*, pp. 144 ff.

[2] See pp. 25 f.

width of 4.5 mm. later narrowed to 1 mm. The pendulum with this radial slit swung behind a stationary screen which also had a vertical slit with parallel sides 2 mm. apart and long enough to expose the full length of the slit behind. Back of both screen and pendulum was ground glass evenly illuminated by six 16-c.p. incandescent lamps. With certain adjustments the observer, at a distance of 2 m., perceived a momentary illumination of the vertical slit in the stationary screen; while with other adjustments the upper and lower half of the radial slit in the pendulum could be mutually so displaced as to present to the observer the two halves of the slit illuminated in quick succession. The exact point in the front slit where these two halves had their common border was, for the sake of preparatory fixation, indicated by white horizontal arrows, while the time-interval between the illumination of the two halves could be exactly controlled by a scale obtained chronographically.

The impression of movement, for the companion experiments, was obtained by another attachment essentially the same as that described in Brewer's paper.[1] It need hardly be said that here the same width of slits and intensity of illumination of background, was maintained as in the experiments on succession, and the extent of the motion was identical with the length of the two illuminated halves then used.[2] And in all cases the two sets of experiments were so arranged as to exclude any difference of practice or fatigue in the two groups. There were two observers in the present group of experiments, as well as in a second group later to be described. To Dr. Brown, who gave unstintingly of time and good will in these none-too-interesting tests, I acknowledge my great indebtedness.

Since the tendency here is to see every impression as motion and indeed as motion in some particular direction,

[1] See p. 258.

[2] Brewer's experiments, it will be seen, showed that the optimal excursion for perceiving *motion* is, unlike that of succession, by no means near zero. With some it seems to lie at least as far out as a visual angle of 18.6′. The motion in the present experiments was some five times this extent, and in all probability included the optimal excursion for my observers.

the 'method of serial groups'[1] was used instead of the more common gradation method. The procedure was '*unwissentlich*'; and but a single movement, or pair of lights in succession, was offered for judgment. At first an attempt was made to distinguish, in each judgment, not only between motion and succession but also between the two orders of succession (upper first; lower first) and the two directions of movement (down; up). But prepossession soon proved too strong, and so wide a range of intervals was needed to catch all phases of these judgments that I finally abandoned the attempt to obtain thresholds for the correct perception of the order of

TABLE I

OBSERVER B

Thresholds expressed in mm. (1 mm. = 1.5σ)

Order of Presentation	With Two Successive Lights		With Moving Light	
	Above-below	Below-above	Downward	Upward
With wider slit.	12 11 18 15	17 17 15 15	35+ 35 45	25 30 25
Average.	14	16	38.3	26.7
With narrower slit.	15 20	20 22	40 35	25 20
Average.	17.5	21	37.5	22.5
Combined average.	15.2	17.7	38	25
Average for the two orders of presentation.	16.4		31.5	

succession and for the direction of motion, which are unquestionably distinct from the thresholds for the perception of mere succession and mere motion. I felt content to note the point at which actual succession on the one hand and motion on the other, no longer seemed sheer simultaneity of illumination. Yet the observers were, through a large part of the present group of experiments, more or less concerned to make out more exactly the nature of whatever departure from simultaneity they noticed, and so their judgments were not quite untrammelled and homogeneous. Yet they should perhaps be entered, since in several ways they are worth

[1] See PSYCHOLOGICAL REVIEW, IX., 444 ff.

comparing with the group to be spoken of some pages hence. Each 'determination' given in the tables accompanying (Tables I. and II.) represents never less than 50 nor more than 100 separate judgments. In all, there were between 1,500 and 1,600 judgments in this group, apart from many preliminary experiments and the half dozen judgments at the opening of each hour for 'warming-up.'

TABLE II

OBSERVER S

Thresholds expressed in mm. (1 mm. = 1.5σ)

Order of Presentation	With Two Successive Lights		With Moving Light	
	Above-below	Below-above	Downward	Upward
With wider slit.	9 8 10 10	20 20 20 20	10 15 10	20 20 15
Average.	9.2	20	11.7	18.3
With narrower slit.	12 13	13 23	8 8	15 17
Average.	12.5	18	8	16
Combined average.	10.3	19.3	10.2	17.4
Average for the two orders of presentation.	14.8		13.8	

The tables show that for Observer B. there was a decided advantage on the side of succession, and for Observer S., no marked advantage either way, although a slight advantage appears on the side of motion. Whatever gain here accrues to 'succession' is not in any wise due to an illusory motion when mere succession was offered. On the contrary, with both observers the presentations, whether of succession or of motion, when just rising above the threshold were perceived as *succession* far more often than as motion. The usual course of the judgments was this; with the longer times there was a clear discrimination between succession and motion; and then, with briefer times, the presentation was called 'successive' or 'different,' meaning that it was not a single simultaneous illumination. Even with actual motion, therefore, the observer failed to notice the motion, but noticed

only non-simultaneity. And this lower threshold is entered in the tables even in the case of motion. Where, with B. for example, the thresholds for motion are entered as 30σ and 35σ, this indicates the point at which a departure from simultaneity was evident; motion was discerned as motion only at 40σ and 45σ respectively; and with S. the detection of motion required a value even higher in its ratio to that of mere succession.

Furthermore, there is a difference, in some cases quite marked, between the thresholds for the different orders of presentation. Thus for both B. and S. the threshold is lower when, in the case of succession, the upper half of the slit is illuminated before rather than after the lower. And with motion also the direction affects the threshold, although here the two observers do not show a like divergence, since B. best catches motion upward, while with S. motion downward has the advantage. But of this phenomenon more will be said in connection with the later experiments.

III. Experiments with Wheel Apparatus

The set of experiments just reported seemed to me inconclusive because of a growing doubt both of the apparatus and of the method. The puzzling disagreement of results obtained in the different orders of presentation, though the observer did not have to decide which order was given him (to which attention has just been drawn), made me perhaps unwarrantably inclined to believe that this inconsistency might be due to some want of rigidity in the instrument. And hesitation arose, too, from the very fact that the values obtained bore, at least in the case of one of the two observers, a relation so decidedly the reverse of that in the classic results.

Consequently an entirely new apparatus was constructed by a skilful instrument-maker—a pendulum-wheel suggested by a device of Sanford's,[1] but departing from it in several respects. From a sheet of aluminum ¼ in. thick, there was cut a narrow circular rim 20 in. in diameter, having thin poke-like connections with its center. At the center there was a steel axle with ball-bearings resting upon a rigid frame and base,

[1] Sanford, *American Journal of Psychology*, VI., 581 ff.

upon which there were levelling screws and a circular spirit level. To the rim of this skeleton wheel was carefully fitted a weight and catches, so that with the weight high upon one side, when one of the catches was released, the wheel revolved until the weight rose high upon the opposite side; and there at its extreme excursion the wheel was caught and the return of the weight prevented. In preparation for the next fall, the rotation of the wheel was completed by hand, and by means of the catch the weight was held high upon the side whence it first fell.

Upon the axle of the wheel was a screw holding two large black bristol disks, one of which was fixed by additional screws upon the rim, the other being movable and to be set instantly at any position desired. In these disks there were in principle, the same devices for producing succession and movement as with the pendulum before. Thus any order and interval of succession, any direction and speed of movement, could be had at will. Proper scaling in thousandths of a second was provided beforehand by tuning-fork records on the disk, the tuning-fork itself having of course been first carefully corrected.

The method was such as to avoid any extraneous advantage accruing, by practice or fatigue, to either of the forms of perception. Experiments upon succession and upon motion were from the first mingled in equal number at every sitting; nor did the observer himself know in any case whether the stimulus to be offered him involved motion or succession merely, nor was he told this after his judgment had been given. But a single movement, a single pair of successive lights, were given for any one judgment. And further it seemed advisable, in view of what had happened in the preceding set of experiments, to simplify the task of the observer and render his judgments more direct and trustworthy. Hitherto, as already has been indicated, the judgments showed some embarrassment before the several possible queries: (1) Was the impression throughout its stretch simultaneous, or was there some departure from perfect simul-

taneity? (2) If there was such a departure, had it the character of a successive illumination of the two halves of the slit; or of a motion? (3) If a succession, did the lower half of the slit flash before or after the upper? (4) If a motion, was this upward, or down? Now the observer is ill at ease before so many questions, and his nicety of judgment is apt to be affected by the attempt to keep his mind at once open to so many aspects of the impression, and in the effort to answer secondary questions the answers to primary are often obscured or lost.[1]

Accordingly in this whole group of experiments, even from the start, the observer was asked to confine his attention to the first of the four questions just listed. Additional judgments were occasionally volunteered; and although noted, they were not encouraged. The method again was, at bottom, that of serial groups, inasmuch as a number of fixed intervals or durations were selected and repeated; and interspersed with these were frequent cases where the interval or duration was reduced to zero. Yet instead of adhering to a particular interval or duration until its group was complete, and exchanged for a new group and so on until the threshold had been passed, there was no attempt to determine a threshold in the accepted sense, but only by a full display of right and wrong cases, with each interval or duration, to reveal the relative facility of perceiving movement and succession. The following partial series of actual stimuli presented, where the distribution is quite by chance, will perhaps make clear the procedure just described.

0σ motion (=simult. illum. of entire slit).
10σ succession, upper-lower.
20σ motion, upward.
30σ succession, lower-upper.
0σ succession (=simult. illum. of entire slit).
10σ motion, upward.
0σ succession.
25σ succession, upper-lower.

[1] See the argument offered by Brown ('The Judgment of Difference,' *University of California Publications in Psychology*, I., 28 ff.) for a simple alternative in the question —an argument that has had great weight with me.

TABLE III

(JUDGMENTS UPON SINGLE PRESENTATIONS; DIRECT VISION)

OBSERVER B

Discrete Succession

Interval[1]	Successes	Failures
30σ	12	0
25σ	12	0
20σ	13	1
15σ	10	4
10σ	10	4
5σ	6	8
Totals.	63	17

Motion

Duration	Successes	Failures
30σ	8	4
25σ	9	3
20σ	10	4
15σ	6	8
10σ	2	12
5σ	6	8
Totals.	41	39

Of 72 instantaneous illums., 50 were judged 'simult.,' 22 'non-simult.'

TABLE IV

(JUDGMENTS UPON SINGLE PRESENTATIONS; DIRECT VISION)

OBSERVER S

Discrete Succession

Interval	Successes	Failures
30σ	10	2
25σ	11	1
20σ	12	0
15σ	9	3
10σ	5	7
5σ	6	6
Totals.	53	19

Motion

Duration	Successes	Failures
30σ	12	0
25σ	9	3
20σ	10	2
15σ	11	1
10σ	7	5
5σ	6	6
Totals.	55	17

Of 72 instantaneous illums., 47 were judged 'simult.,' 26 'non-simult.'

[1] 'Interval' here and elsewhere means the time between beginning and beginning, or end and end, of the two successive flashes.

20σ motion upward.
15σ succession, lower-upper.
5σ motion, downward.
0σ succession.
30σ motion, upward.
0σ motion, etc.

The following tables exhibit the results of these experiments.

Method of Paired Presentations.—Before discussing these results, let me offer also those of another method, used as a check. Here the apparatus and procedure was in all respects as just described, except that there was given, in sequence, two presentations; namely, a zero case—where there was absolute simultaneity of illumination—and a case where there was actual succession or motion. The observer was told that there would be two presentations, one of which would be a simultaneous illumination of the entire slit, the other a departure from such simultaneity; and that his task was simply to tell whether the simultaneous illumination occurred first or second in the pair. The two presentations were then given, with as little time between as could be with the adjustment required (about 4 seconds), and no judgment was passed until after the appearance of the second of the pair. The

TABLE V

(JUDGMENT BY PAIRS; DIRECT VISION)

OBSERVER B

Discrete Succession

Interval	Successes	Failures
20σ	11	1
15σ	10	2
10σ	8	4
5σ	6	6
Totals.	35	13

Motion

Duration	Successes	Failures
20σ	7	5
15σ	8	4
10σ	8	4
5σ	4	8
Totals.	27	21

TABLE VI

(JUDGMENT BY PAIRS; DIRECT VISION)

OBSERVER S

Discrete Succession

Interval	Successes	Failures
20σ	14	0
15σ	10	4
10σ	11	3
5σ	11	3
Totals.	46	10

Motion

Duration	Successes	Failures
20σ	13	1
15σ	13	1
10σ	7	7
5σ	6	8
Totals.	39	17

observer was ignorant of the actual order, and this order itself was irregularly changed. The following tables exhibit the results obtained.

Examination of the results of these two different procedures discloses that with neither of the observers, nor by either method, is there an advantage for motion over succession. And consequently the new apparatus and simplified task for the observer brings the same general relation of values as were obtained in the first set of experiments with the pendulum. Observer B. now, as before, can more readily detect a departure from simultaneity in the illumination when departure actually is of succession rather than of motion. Observer S. again, for a part of the set—when there were single presentations—shows about equal facility with either kind of stimulus; but with double presentations shows greater ease in dealing with successsion.

Any one interested in method, and in the psychological indications arising from differences therein, will perhaps feel inclined to compare more closely the outcome by single presentation (Tables III. and IV.) and by double (Tables V. and VI.). It will be seen that Observer B. has, so far as discrete succession is concerned, a slightly greater success by the method of double presentation, and with motion he shows

a decidedly higher ratio of successes to failures when the presentation is in pairs. Observer S., when discrete sequence is offered, succeeds markedly better with pair-presentations than with single-presentations; when motion is offered, the ad-

TABLE VII

OBSERVER B. DIRECT VISION

With Discrete Succession

Time Interval	Judgment by Single Presentation		Judgment by Double Presentation	
	Successes	Failures	Successes	Failures
20σ	13	1	11	1
15σ	10	4	10	2
10σ	10	4	8	4
5σ	6	8	6	6
Totals	39	17	35	13
Ratio of successes to failures	2.3 : 1		2.7 : 1	

With Motion

Duration	Judgment by Single Presentation		Judgment by Double Presentation	
	Successes	Failures	Successes	Failures
20σ	10	4	7	5
15σ	6	8	8	4
10σ	2	12	8	4
5σ	6	8	4	8
Totals	24	32	27	21
Ratio of successes to failures	0.75 : 1		1.3 : 1	

TABLE VIII

OBSERVER S. DIRECT VISION

With Discrete Succession

Interval	Judgment by Single Presentation		Judgment by Double Presentation	
	Successes	Failures	Successes	Failures
20σ	12	0	14	0
15σ	9	3	10	4
10σ	5	7	11	3
5σ	6	6	11	3
Totals	32	16	46	10
Ratio of successes to failures	2 : 1		4.6 : 1	

With Motion

Duration	Judgment by Single Presentation		Judgment by Double Presentation	
	Successes	Failures	Successes	Failures
20σ	10	2	13	1
15σ	11	1	13	1
10σ	7	5	7	7
5σ	6	6	6	8
Totals	34	14	39	17
Ratio of successes to failures	2.4 : 1		2.3 : 1	

vantage for the method in which pairs of presentations occur disappears. The following tables (VII. and VIII.) in which the comparable values are isolated and set side by side and summed, will, I trust, make this more clear.

In general it would appear that a greater fineness of perception is possible by the method of paired presentation than by that of single presentation. And furthermore there is noticeable in the values obtained by the method of paired presentations a somewhat greater regularity; the number of successes or of failures keeps better step with the change in the time-interval, the correlation between the interval employed and the success of perception is closer when this method is employed than when its rival.

Experiments with Eccentric Vision.—Such was the evidence upon the main problem, so far as a foveal vision is concerned. Experiments were tried also with eccentric vision, the observer fixating with both eyes a point 20° to the left of the slit in which the illumination appeared. Tables IX.

Table IX

Experiments with Eccentric Vision

Observer B

Time	Discrete Succession		Motion	
	Successes	Failures	Successes	Failures
30σ	11	1	10	2
25σ	8	4	10	2
20σ	6	6	6	6
15σ	8	4	8	4
Totals.	33	15	34	14

TABLE X

EXPERIMENTS WITH ECCENTRIC VISION

Observer S

Time	Discrete Succession		Motion	
	Successes	Failures	Successes	Failures
30σ	4	0	4	0
25σ	3	1	4	0
20σ	11	1	11	1
15σ	9	3	9	3
10σ	9	3	6	6
5σ	9	3	4	8
Totals.	45	11	38	18

and X. show the results of these experiments. The presentations were always by pairs; the procedure was in all other respects as last described.

Under these conditions it is apparent that, with Observer B., there was almost equal success with either kind of stimulus, although the values indicate in both cases a higher threshold than with direct vision. With Observer S., there is somewhat greater facility in dealing with succession than with motion, although here the values indicate no rise of the threshold. Thus in this region as in others, succession is certainly at no disadvantage as compared with movement.

Absolute Time in the Results.—As for the absolute time-values obtained in these experiments, they run considerably lower than we have been accustomed to regard as obtaining here. It will be recalled[1] that Exner found 15σ to be the duration needed for perceiving motion; 45σ, for discrete succession. Bourdon recognized motion at 27σ; with discrete succession right judgments exceeded wrong at 20σ; the time order of succession was caught with certainty at 48σ. Weyer found a slight drag at 12σ, a 'flicker' at 25σ–30σ, clear succession at 43σ–53σ. Charpentier discerned succession at 27σ.

In the portion of the present experiments where the vision was direct and the conditions otherwise were most favorable, Observer S., even with so brief an interval as 5σ, distinguished succession from simultaneity 11 times in 14 trials (*i. e.*, 80 per cent. of the judgments were correct; *cf.* Table VI., p.) 277. B.,

[1] See pp. 263 ff. of the present paper.

when the interval was 10σ, correctly made this distinction in 10 of the 14 cases offered him (70 per cent.; *cf.* Table III., p. 275, and Table V., p. 276, where two thirds of B.'s answers were correct, with 10σ). And, again, with indirect vision, an interval of but 5σ still permitted Observer S. to give correct judgments regarding discrete succession in 9 cases out of 12 (75 per cent.; *cf.* Table X., above.

Such a lowering of the time-threshold to about one third of what usually has been considered its lowest value (to 5σ, as against 15σ), if motion be regarded as offering the finest measure of the time-threshold; or to about one ninth of its accepted value (to 5σ, as against 45σ) if succession be taken as criterion,—this lowering is to be ascribed to a combination of causes: perhaps (1) to the method of presentation, inasmuch as examples both of simultaneity and of non-simultaneity, it was known, would be offered, and the observer had simply to affirm which was which; and (2) to the instrumental arrangement,—whereby there was given an immediate juxtaposition of successive lights, yet without fusion—an arrangement analogous to the successful 'vernier-method' in experiments with space; and (3) to practice, since with each subject a far greater number of experiments was completed than has been usual in this field.

Some might feel tempted to say that the lowering of the values arose from the fact that the judgments here given were not due in the first instance to time-perception at all; that they were time-judgments, but derived from an appearance not primarily temporal—derived perhaps from intensive differences in the light at the point of junction of the two halves of the slit. I have myself tried impartially to entertain a supposition of this kind, but after serving long as an observer in the experiment the phenomenon has seemed too me clearly a time-phenomenon; has seemed to be the conscious presence or absence of precise and punctual synchronousness in the luminous slit. There appeared to me no intensive difference between a pair of lights that were exactly simultaneous and a pair in which succession was just discernible; nor is it probable, although still conceivable, that such a difference was there.

Optimal Orders or Directions.—To one other aspect of the observers' judgments attention might be called,—namely to an occasional partiality which the observers had for a particular *order* of succession, a particular *direction* of movement. If we segregate the judgments passed upon a succession actually 'above-below,' and again the judgments passed upon a succession actually 'below-above'; and likewise with motion downward and motion upward, we obtain the values set forth in Tables XI. and XII.

Table XI

Observer B

Segregation of Different Orders and Directions

Time	Succession				Motion				
	Above-below		Below-above		Downward		Upward		
	Successes	Failures	Successes	Failures	Successes	Failures	Successes	Failures	
30σ	6	0	6	0	4	2	4	2	Single presentation—direct vision.
25σ	6	0	6	0	5	1	4	2	
20σ	7	0	6	1	5	2	5	2	
15σ	4	3	6	1	4	3	2	5	
10σ	6	1	4	3	2	5	0	7	
5σ	3	4	3	4	2	5	4	3	
Total.	32	8	31	9	22	18	19	21	
20σ	6	0	5	1	2	4	5	1	Presentation in pairs—direct vision.
15σ	5	1	5	1	5	1	3	3	
10σ	4	2	4	2	4	2	4	2	
5σ	3	3	3	3	0	6	4	2	
Total.	18	6	17	7	11	13	16	8	
30σ	5	1	6	0	5	1	5	1	Presentation in pairs—indirect vision.
25σ	4	2	4	2	5	1	5	1	
20σ	3	3	3	3	2	4	4	2	
15σ	4	2	4	2	2	4	6	0	
Total.	16	8	17	7	14	10	20	4	
Grand total.	66	22	65	23	47	41	55	33	

In Table XII. (Observer S.) it will be noticed that with succession, when the order is above-below the total number of successes is 81, as against 63, when the order is reversed (below-above); and likewise with motion, when direction is downward the successes are 74, as against 58 when the direction is reversed. And this relation that appears in the grand

TABLE XII

OBSERVER S

Segregation of Different Orders and Directions

Time	Succession				Motion				
	Above-below		Below-above		Downward		Upward		
	Successes	Failures	Successes	Failures	Successes	Failures	Successes	Failures	
30σ	5	1	5	1	6	0	6	0	Single presentations — direct vision.
25σ	6	0	5	1	5	1	4	2	
20σ	6	0	6	0	6	0	4	2	
15σ	6	0	3	3	6	0	5	1	
10σ	5	1	0	6	4	2	3	3	
5σ	4	2	2	4	3	3	3	3	
Total.	32	4	21	15	30	6	25	11	
20σ	7	0	7	0	6	1	7	0	Presentation by pairs—direct vision.
15σ	6	1	4	3	7	0	6	1	
10σ	6	1	5	2	5	2	2	5	
5σ	6	1	5	2	4	3	2	5	
Total.	25	3	21	7	22	6	17	11	
30σ	2	0	2	0	2	0	2	0	Presentation by pairs—indirect vision.
25σ	2	0	1	1	2	0	2	0	
20σ	5	1	6	0	6	0	5	1	
15σ	4	2	5	1	5	1	4	2	
10σ	6	0	3	3	5	1	1	5	
5σ	5	1	4	2	2	4	2	4	
Total.	24	4	21	7	22	6	16	12	
Grand total.	81	11	63	29	74	18	58	34	

totals also appears in the sub-totals obtained by each separate method and region of the retina; there is invariably greater success with the order 'above-below,' invariably greater success with the direction downward.

In Table XI. (Observer B.), the partiality is exceedingly faint, if not entirely absent; certainly absent when succession is being offered, for here the total number of right judgments when the order is 'above-below' is almost exactly the same as with the reverse order (66 as against 65) ,and the sub-totals show a like approximation. But with motion there is perhaps a slight partiality for the upward direction (55 successes as against 47 with motion downward),—a partiality, however, so phlegmatic that a mere change of method from double to single presentation is sufficient to reverse it.

Nor is the partiality confined to differences in vertical direction; it appears in experiments with the horizontal direction as well. With Observer S., in whom the difference in result for the different orders of appearance was most pronounced, supplemental experiments were tried in which the stationary slit (*i. e.*, the slit upon the front screen) lay in a horizontal instead of a vertical position, and with the rest of the apparatus so adjusted as to give illuminations of the two halves of the slit in the order 'left-right,' as well as in the order 'right-left.' And also (to answer the question whether the advantage might in any way be due to the fact that the stationary slit was a parallelogram and so permitted the half of the illumination that came from that portion of the radial slit lying nearer the center of the wheel to appear an almost infinitesimally longer period than the illumination from the more distant portion), experiments were performed with two different characters of stationary slit,—in the one case, as hitherto, with sides exactly parallel; in the other case, with sides slightly departing from this arrangement, so that,

TABLE XIII

OBSERVER S. DIRECT VISION, PAIR PRESENTATION, HORIZONTAL DIRECTION

Succession

Time	Left-right		Right-left		
	Successes	Failures	Successes	Failures	
10σ	11	1	12	0	With parallelogram slit.
5σ	6	18	19	5	
	17	19	31	5	
10σ	9	3	12	0	With radial slit.
5σ	6	6	12	0	
	15	9	24	0	
Total.	32	28	55	5	

had they been extended, they would have met at the center of the wheel (*i. e.*, a *radial* slit instead of a narrow parallelogram). Thus both halves of the slit gave absolutely equal durations of illumination. In all other respects the procedure was unchanged. Table XIII. shows the outcome of these experiments.

The advantage, which with the vertical slit was for the order 'above-below,' here reappears strong, and for the order 'right-left.' Out of 60 trials with this particular order, but 5 errors were made; whereas for a like number of trials with the opposite order 28 errors were made.

These partialities had already been noticed, as I have said, in the earlier experiments, with the pendulum; and in Table XIV. they are set forth in conjunction with those found in the later experiments.

Table XIV

Unconscious Partialities for Particular Orders and Directions

(*I. e.*, the order or direction in which there was heightened facility, or lowered threshold.)

Observer	In Case of Succession		In Case of Motion	
	Earlier Experiments (Pendulum)	Later Experiments (Wheel)	Earlier Experiments (Pendulum)	Later Experiments (Wheel)
B	above-below (slight)	no preference	upward	upward (slight)
S	above-below	above-below right-left	downward	downward

The suspicion with which I closed the earlier set of experiments, that such partiality was a mere appearance due to some aberration in the apparatus[1] was thus evidently unwarranted. The unequal facility of dealing with the rival orders and rival directions reappears in the later experiments and in the same general sense: the preference for upward motion in the earlier experiments in answered by a preference for the upward motion in the later; the preference for the succession 'above-below' is answered by a preference for this same succession. Only in B., in whom the tendency is weak at best, the partiality grows less in the later experiments, passing away entirely in the case of succession. It is thus an individual matter; for the different observers do not agree in their partialities; and of course it is not to be regarded as a conscious liking. No observer *expressed any preference* for an order or a direction. By 'partiality' is meant, then, no emotional difference, but merely a greater

[1] See p. 272.

ability of perception or of discrimination. It seems to have some similarity (though I can hardly believe that there is any causal connection between the two) to the greater aptitude for detecting a departure from linear continuity when the departure was upon the right, rather than upon the left, of the standard vertical;[1] or to the personal differences in dealing with successive shocks and successive clicks which others have found.[2] In explanation of the partialities appearing in the present experiments, I feel tempted to believe that they may be due to certain obscure habits or tricks of attention. It is probable that, other things equal, some persons are slightly more ready to attend to an object in the upper half of the visual field than in the lower; while with the others the reverse may be true. One whose attention had any such inclination would seem to have the foundation for a partiality like that of the present experiment. It is significant, in this connection, that with S., the advantage which a particular order of succession holds is shared by the corresponding direction of motion. With B., however, this is not true, at the very time when succession in the order 'above-below' had an advantage, the advantage in the region of motion lay with the direction opposed to this, lay namely with motion upward.

V. The Precise Relation between Succession and Motion

Turning now to the main question, which serves as a title to this paper, I believe we shall be more likely to succeed in answering it if we divide and attend to each division separately. (1) Is the consciousness of rapid motion (such as we have had in these experiments) intimately bound up with the consciousness of succession; or are they distinct and even independent mental processes? (2) Are these mental processes, whatever their relation may be, rightly designated as *sensations?* These are separate questions, although the an-

[1] See 'A New Determination of the Minimum Visibile,' etc., Psychological Review, VII., 429; and 'Visible Motion and the Space Threshold,' Psychological Review, IX., 433.

[2] Hamlin, 'On the Least Observable Interval,' etc., *Amer. Journ. of Psychol.*, VI. 564 ff. Drew, 'Attention,' *Amer. Journ. of Psychol.*, VII., 533 ff.

swer to one may involve or determine the answer to the other.

In answer to the preceding of these questions, one may speak first in negatives. I am inclined to believe that the facts brought out by the present experiments, in conjunction with what has been done before, very nearly annul the supposed evidence for the independence of succession and motion; at least so far as the claim for the priority of motion is concerned. For it is now apparent that the detection of motion is nicer than that of discrete succession neither on the spatial side nor yet upon the temporal. Motion cannot be discerned within space-limits too small for discriminating positions; nor within time-limits too narrow to permit the conscious distinction of instants.[1]

On the other hand, a certain claim might now be set up for the priority of discrete sequence. For upon the whole, the threshold when 'succession' was employed was lower than when there was motion. Moreover this meant not simply that an external and objective succession broke up the appearance of simultaneity more readily than did motion, but that the observers were inclined, under the conditions here arranged, and with continued practice, to give their judgment of such non-simultaneity in the form 'sequence' long before they were ready to declare it to be 'motion.' And, indeed, this seems to me in keeping with what we know from a wide variety of experiments: in keeping with the greater ease in deciding the vaguer—the more abstract—feature of an impression; for the decision as to the more definite, the more concrete, characteristics comes later and with more difficulty. Since, in contradiction to Berkeley's principle, we can tell that a pressure has changed, far more readily than we can decide whether it has become heavier or lighter;[2] and since

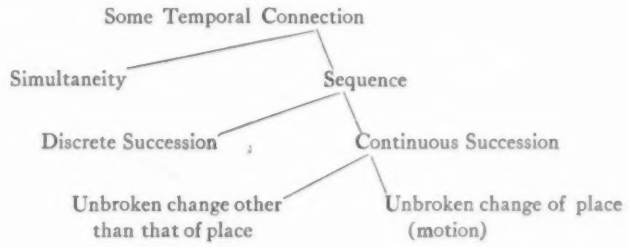
[1] Nor, it might be added, can motion be noticed at an *intensity* too weak for the detection of a motionless light. Contrary to a certain prejudice aroused by the *attention* which moving objects so readily command, a moving light, when attention is full upon it, cannot be seen at so low an intensity of stimulus, as can a stationary light. Here again the supposed sensory-advantage of motion proves ill-claimed. See 'Some Experiments on the Perception of the Movement, Color, and Direction of Lights,' etc., in the *Johns Hopkins Studies in Philosophy and Psychology*, No. 2, pp. 88 f.

[2] See 'Ueber die Wahrnehmung von Druckänderungen,' etc., in Wundt's *Philos. Studien*, XII., 534 ff., 539.

we show a like tendency in many other fields; it would not be surprising if, at bottom, it were easier to decide that simultaneity had in some general way been violated,—that the impression was in some vague form *successive*,—perhaps even without being of a succession distinctly *discrete*—than to decide whether it was succession plus those special and particular marks of *continuity both in space and time* that characterize motion. Succession means merely change; discrete succession means change with some temporal interim or cessation of the process, motion means that the change has no such temporal interim, and furthermore that there is perfect continuity, along with shift, in the space involved. But such an account implies some weakening of the claim to priority on the part of *discrete* succession; for this is almost, though not quite, as advanced a specification of succession as motion is.

The positive side of the answer to the question as to the relation of sequence and motion would therefore seem to me to be this: that motion involves as a constituent element sequence although not discrete sequence; the rather it involves sequence particularized in a way soon to be described; but in any event, that motion is the more special and advanced form of the sequence-consciousness. Yet it is the one to which the mind rushes headlong. For just as in our perception we hasten to fill out the lacunæ of impression, even at the risk of illusion; just as it is, in one sense, far easier to see *as a man* the form and color which a human being offers to the eye and color; and yet this interpretation, while most difficult to suppress, is an advance and addition to the consciousness of mere form and color—so with motion. The rapid sensory sequences which nature offers us in any one region of space are predominantly *continuous* sequences—continuous in both space and time; the flutter of leaves and of grass, the darting of birds and of insects, the quick action of eyes and lips and fingers in men about us. And so the mind becomes accustomed to this manner of interpreting all rapid change; it interprets it instinctively as *motion*. But

this precipitancy of nterpretation should deceive the psychological analyst no more in the one case than in the other. As little as we should now be inclined to say that the perception of a cow is independent of the consciousness of extensity, although most of us see cows in a field more readily than red-extensities there; so little in the end will we be inclined to regard motion, for all its greater readiness to arise in the mind, as independent of sequence or succession. Motion is different from sequence, whether discrete or continuous, but only inasmuch as it is sequence made specific, made more concrete by giving it a peculiar spatial character. The relation of those processes, so far as complexity and dependence is concerned, might be illustrated by the accompanying diagram.



When the mind is not on its guard, it rushes, on the slightest excuse, through all the intermediate stages to a conviction of movement. In that sense, the motion-interpretation is simpler; it is more natural, it is the course in which experience has drilled us. But the mind needs a more *intense* stimulation, it requires an impression whose differential marks are more pronounced, if the mind is to be, not merely more confident, but actually more accurate in detecting the real character of the change presented to it. Practiced observers therefore when confronted with faint changes such as occurred in these experiments unwittingly fall back, sooner or later, on the less commital form of judgment—that of 'succession' merely; passing on to the farther specification,—the judgment that the succession is actually of 'motion'—only when the impression has become more clear. They have become schooled out of their impulsive readiness to take all rapid

visual change (unless there are unmistakable signs to the contrary) as movement.[1]

But the fact that, on the whole, my observers reserved the judgment 'movement' for the more pronounced and definite stimulations, and usually formed only the vaguer judgment 'sequence' or 'succession' or 'some departure from simultaneity,' when the impression was approaching its liminal value,—this does not touch the farther question as to what form of stimulus will best furnish the definiteness of impression that permits even the vaguer judgment to be passed reliably. It would seem from the present experiments that with trained observers discrete succession customarily gives a much greater shock, a less mistakable violation of simultaneity, than does continuous succession (motion). A less time suffices to make discrete succession seem non-simultaneous, than is required to make motion distinct from simultaneity. At times this is not so; the just-perceptible violation of simultaneity comes equally well from either source. But the other relation is perhaps the rule. Indeed, this would seem in keeping with the general intensification and shock and start which interruptions give, and the greater ease and smoothness of continuous change.

To sum up then the answer to the first of our questions, Whether the consciousness of rapid motion is intimately bound up with the consciousness of succession, or is independent; it is this: *that the two are intimately conjoined, the judgment of motion being a farther specification (more complex, and yet easier) of the judgment of sequence. The judgment of motion has a certain priority, in the sense that it is both more complex and also more readily performed,* much as the movement of four fingers of a hand is easier, though more complex, than the movement of one finger alone. *The judgment of succession, however, has its own priority, inasmuch as it is the simpler, and requires a less lasting stimulation to evoke it.*

And the answer to this first question has perhaps already

[1] This naïve readiness is well seen in the almost inevitable impression of 'winking' which a rapid intermission of light produces. The twinkling of stars with its sense of motion is, I doubt not, three fourths motion-illusion due to rapid intensive change, the other fourth the actual shift that the light undergoes by changes of refraction.

suggested the answer I feel bound to give to the second,—the question whether the consciousness of succession or of movement (even when rapid) is to be designated as *sensation*. In dealing here with out consciousness of succession and of movement the expression 'judgment' has often been employed; and yet there is hardly any need of warning that the core-substance of succession or of motion, as they here appear, is not a mere judgment, but has a strong admixture of sensation. We *see* the succession, we *see* the movement, whatever judgments we may pass upon it. But inasmuch as the conscious succession, the conscious movement, involves a certain relating and interpreting (as I have attempted to indicate, especially in regard to motion), *it would seem preferable*—if one were to limit himself to the usual alternatives—*to regard it as a perception, rather than as either a sensation or a judgment.* The sensory impression is here grasped in its simple relations of time, it is here interpreted and felt to belong to a certain familiar type of experience. And just as we speak of the perception of a cow, and the sensation of red; so too in principle (though now the span between the bare impression and its 'form' or 'system' is almost too small for observation) we must distinguish the perception of succession (or the perception of motion) from the sensations which are its ingredients and sign. The term 'sensation,' I take it, designates a sheer abstraction, designates the 'matter' of sensory impressions as distinguished from their 'form.' If then the peculiar meaning of sensation and its distinction from perception (as a consciously formed or organized impression) is to be preserved, it seems best to regard the conscious process with which we have here been so long dealing as a perception or percept, rather than as a sensation.

Yet perhaps the negative side of the argument—that these processes are *not* mere sensations—is perhaps more convincing than the positive side, which urges that they be called 'perceptions.' For the term 'perception' covers an idea that must in time be resurveyed and subdivided. We are sadly in need of a more precise expression here, and were it not for a natural hesitation at new terms, one would feel tempted to

propose that (since no external object is here 'received' or 'taken' through the sense, or the sensation,—which is a prominent element in at least the earlier idea of perception) we designate these simple organizations of sensory 'matter' where no physical 'thing' is caught, as 'infra-percepts,' or 'æsthamorphs.' For there is here the need of marking a stage where sensation has been organized, yet not organized into a perceptive object or thing.

Summary

1. When successive lights are exactly juxtaposed spatially, motion that is just perceived does not occupy a briefer time than mere succession that is just perceived.

2. On the contrary, practiced observers can usually perceive mere succession whose time-limits are less than those of just-noticeable motion.

3. And the judgment of such observers more readily takes a form affirming mere non-simultaneity rather than motion.

4. Under the conditions here arranged, a succession of lights but 5σ apart could be discerned by the writer in 80 per cent. of the trials,—and the other observer also detected succession considerably below the limits hitherto accepted as obtaining in this region.

5. For each person, there is usually an optimal direction of succession or of movement. That is, a succession or movement in the order above-below (or the reverse) may be noticed at a rate at which the succession or motion in the opposite direction is quite imperceptible. This preferred order is not the same for all persons, and in the same individual the preferred order for succession need not be the preferred order for motion.

6. The general relations described above appear to obtain in eccentric as well as in foveal vision, although the absolute values in the two regions may differ.

7. A change of method from that of single presentations to the method of paired presentations generally brings about both a nicer and a more constant recognition of the phenomenon offered.

8. The relation between the consciousness of succession and that of motion is exceedingly intricate. The consciousness of motion is a farther 'specification' of the consciousness of succession, somewhat as the consciousness of increase or decrease of pressure is a farther specification of the consciousness of mere change of pressure. The two orders of perception are certainly distinct, although quite as certainly not independent, since the more specific apprehension always involves the less specific, but not *vice versa*. The seeing of motion is a more elaborate, and yet at the same time more facile mental act, than the seeing of mere succession. The headlong readiness to interpret all neighboring successions as *motions*, to which the world has trained the mind, can however be checked by special and cautious observation, and then the essentially simpler judgment or perception, that of mere succession, is the one that more readily arises.

9. The consciousness of rapid motion or of rapid succession is not a mere sensation, nor is it a mere judgment, nor again is it a perception in the older historic meaning of the term. It is rather a sensation or group of sensations consciously organized, and yet not organized into anything so concrete as a 'thing' or a substantial object. It therefore lies somewhere between sensation and perception, and seems to call for a special designation,—perhaps 'infra-percepts' or 'æsthamorphs.'

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